electronics

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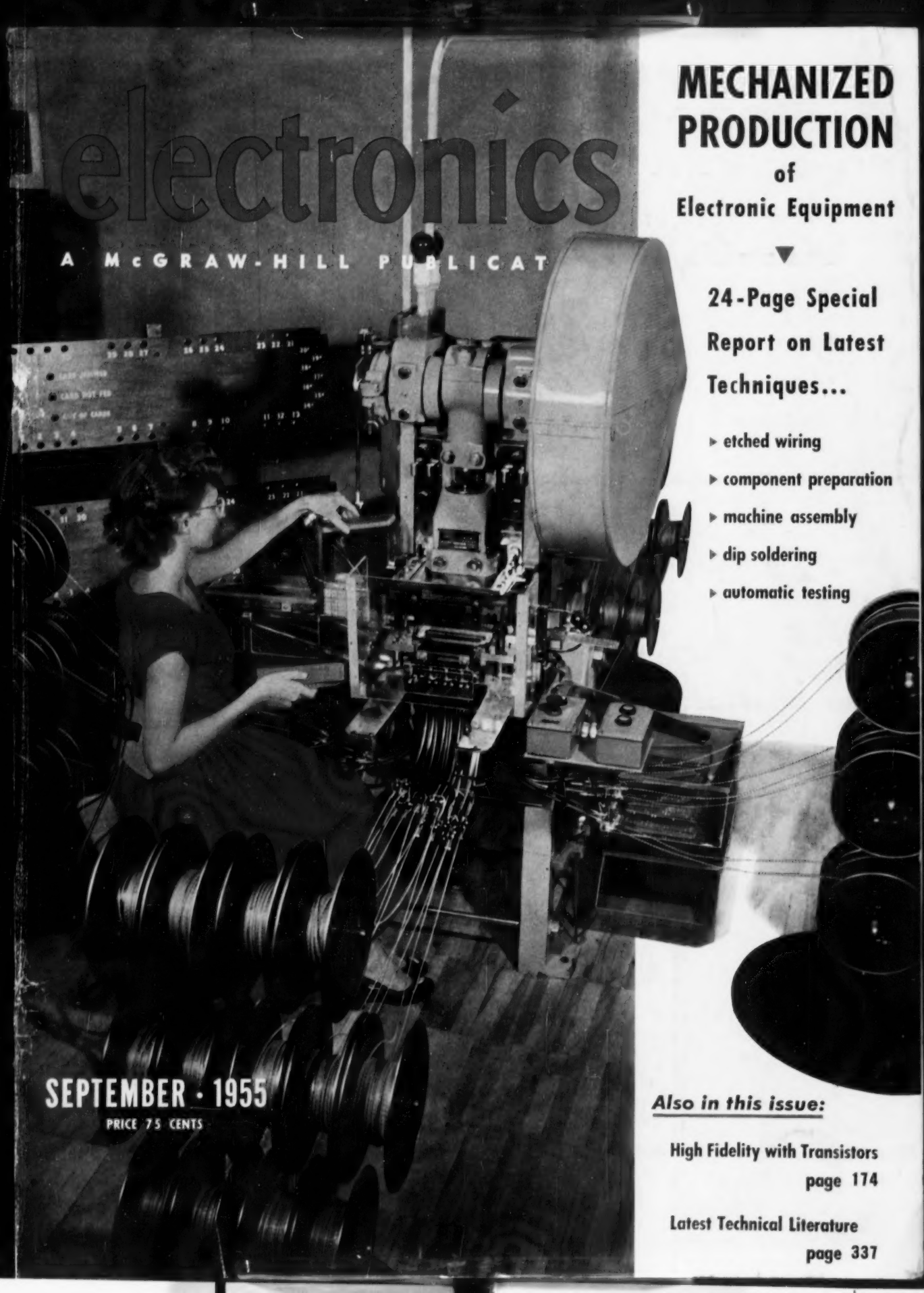

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- component preparation
- machine assembly
- dip soldering
- automatic testing

SEPTEMBER · 1955

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Also in this issue:

High Fidelity with Transistors page 174

Latest Technical Literature page 337

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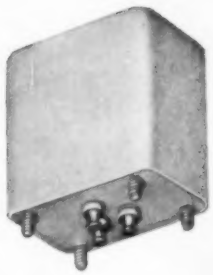

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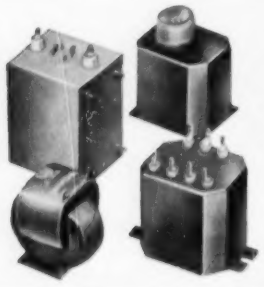

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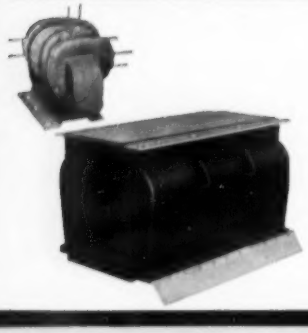

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UTC molded units range from ⅛ oz. miniatures to the 100 lb. 3 phase unit illustrated.

PULSE TRANSFORMERS

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MINIATURIZED COMPONENTS

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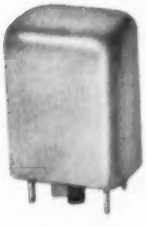

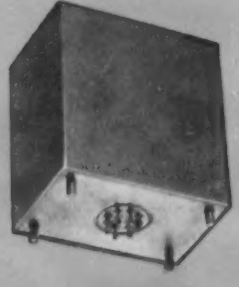

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AUTOMATIC TERMINAL INSERTER—Machine built for IBM's Kingston, N. Y. plant by Berg Manufacturing and Engineering stakes up to 41 lugs in etched wiring boards for radar computer. Photo by E. J. Casazza (see p 137) COVER

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SHOP

IN THIS ISSUE—Three months on special assignment, to survey the state of mechanization of the electronics industry, resulted in a multitude of experiences for associate editor Markus.

These included taking off from a cow-pasture-size airport in a DC-3 at twilight in Indiana, having a union steward threaten to strike a whole plant if "that guy" didn't stop taking pictures, getting thoroughly dusty near the ceiling of another plant while searching for the most photogenic camera angle of a long line assembly machine, riding to another plant in a photographer's Lincoln Capri with elevator seats, and finding his photographs mysteriously fuzzed in the vicinity of one most interesting gadget, yet perfectly sharp everywhere else.

At one plant, a blustering red-faced foreman dashed up screaming, "Eight rejects have come down the line since you guys started taking pictures; get out of here!"

Markus traveled over 5,000 miles. Corresponded with a hundred manufacturers of components and complete electronic equipments. Made and received enough long-distance telephone calls to go once around the world. Reports and other material fill a three-foot bookshelf.

He also acquired enough samples of "new look" components to fill a desk drawer; in fact, after filling pockets while going through one television plant, the vice president thoughtfully offered to align the

electronics

SEPTEMBER, 1955 Vol. 28, No. 9

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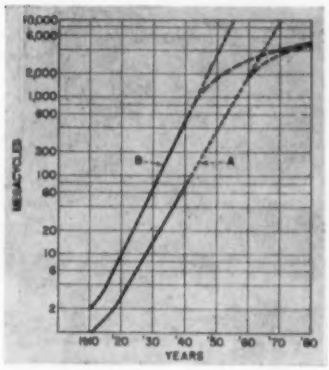
TALK

tv set after editor Markus had put it together.

OF PROPAGATION – The current flurry over so-called scatter propagation (ELECTRONICS, p 149, Mar. '55) has sent the editors digging into yearly indexes and files to answer phone calls. Among the items of interest is "Reliable VHF Signals Up to 1,250 Miles Distance", abstracted from a Bureau of Standards report by Alex McKenzie and published on page 102 of the June 1952 issue. This described ionospheric forward scatter.

Another, which has to do with "backscatter", is entitled "COZI, Communication Zone Indicator" and shows a method of measuring skip distance instantaneously. Some callers seem glad to know about the piece in EAW (p 196, May '54) that summarizes diffraction-gain transmission experiments – although this beyond-the-horizon mechanism has little in common with scatter.

One dividend of this file-combing is shown in the illustration. Until now unpublished, the graph shows a forecast of maximum frequency usage as well as actual past usage. It was compiled in 1940 by a well-known engineer (now retired) of a large electronics firm (still in business). Curve *B*, representing stabilized laboratory use, leads in frequency over curve *A*, which indicates wide commercial use. The compiler said, at the time, " . . . practical considerations of propagation, apparatus and service may begin to limit the increase at 2 or 3 kmc and a final limit, for communication purposes, may be reached at 4, 5, 6 or 10 kmc. This possibility is shown in dashed lines."



ELECTRONICS file divulged this old graph prepared by a leading engineer in 1940. Frequency use in laboratories (*B*) and commercially (*A*) are extrapolated from 1940

REFLECTS INDUSTRY—Activities of readers at work certainly shows up in a comparison of our first Buyers' Guide, published in 1941, with the issue just released.

About 175 major products were listed in 1941, while today over 1,700 individual products are classified. The early issue contained 1,400 manufacturers producing for electronics; now there are over 3,000.

The first Guide was included in a regular issue and contained 65 pages. The current issue is a separate publication totaling 1,054 pages, of which 228 make up the directory information section.

SOLVENT NEEDED—One reader who clips articles for preservation in group binders finds it easy to remove the staples but difficult to remove the glued pages from the backing. Since the magazine is made up of groups of double-pages folded in half, only the outer double page of each group is glued. But there are enough to be troublesome, if neat pages are required.

AUTHORS' NOTE – More than the usual number of engineers have contacted the editors in recent months asking questions that have to do with the mechanical details of preparing a manuscript. Such as what size paper, drawings, photographs and so on. We like that.

What puzzles us is that some of these potential authors are reticent as to the subject matter of the proposed article. They seem reluctant to tell us what is new and different about the equipment or technique and feel that the article will explain that.

But the subject is our major interest, and the reader's major interest.

When you plan to do an article, please do get in touch with us before you get involved in the mechanics of putting it together. Write, phone or stop in, with as much technical information as possible. Maybe we can help, then, in advising on the mechanics and avoid rewriting later.

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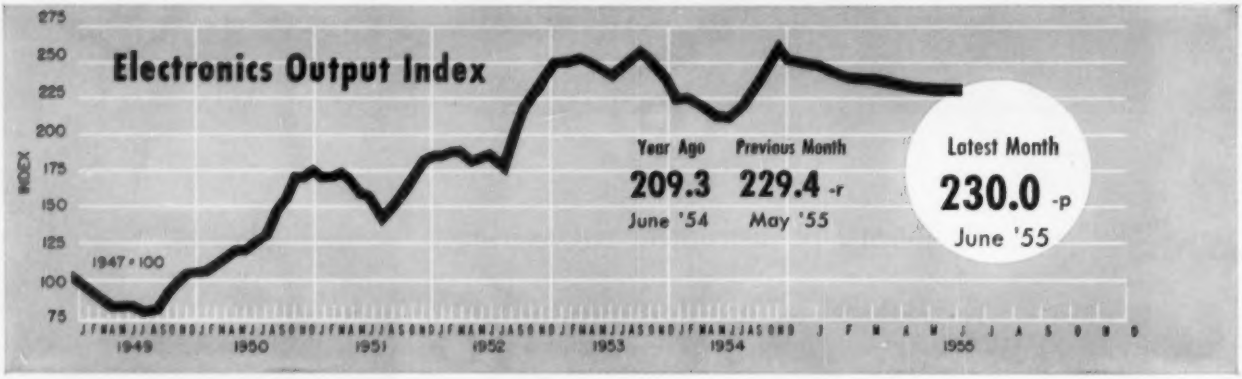


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month: June '55	Previous Month: May '55	Year Ago: June '54
Television sets, total	589,973	467,394	544,142
With UHF	59,892	61,784	99,404
Color sets	nr	nr	347
Radio sets, total	1,204,935	1,114,035	837,655
With F-M	9,106	8,726	15,854
Home sets	181,930	161,357	226,350
Clock radios	182,605	130,608	132,668
Portable sets	255,833	258,701	141,904
Auto sets	584,567	563,369	336,733

RECEIVER SALES

(Source: RETMA)	June '55	May '55	June '54
Television sets, units	429,357	416,908	351,885
Radio sets (except auto)	421,387	398,449	537,494

RECEIVING TUBE SALES

(Source: RETMA)	June '55	May '55	June '54
Receiv. tubes, total units	40,819,961	32,920,310	31,031,315
Receiv. tubes, value	$31,254,324	$25,914,821	$21,694,500
Picture tubes, total units	706,890	779,324	681,937
Picture tubes, value	$13,244,499	$14,572,518	$13,933,845

SEMICONDUCTOR SALES

	May '55	Apr. '55	May '54
Germanium diodes, units Silicon diodes, units	1,493,211	1,419,245	1,001,905

INDUSTRIAL TUBE SALES

(Source: NEMA)	Quarterly Figures — Latest Quarter: 1st '55	Previous Quarter: 4th '54	Year Ago: 1st '54
Vacuum (non-receiving)	$8,784,478	$9,338,181	$8,971,335
Gas or vapor	$3,747,490	$3,498,123	$4,589,239
Phototubes	nr	nr	nr
Magnetrons and velocity modulation tubes	$14,229,442	$15,249,651	$16,135,274
Gaps and T/R boxes	$1,434,683	$1,788,780	$1,517,426

TV SETS INSTALLED

(Source: NBC Research Dept.)	Latest Month: July '55	Previous Month: June '55	Year Ago: July '54
Total sets	36,477,000	36,100,000	30,717,000

BROADCAST STATIONS

(Source: FCC)	July '55	June '55	July '54
TV stations on air	461	458	409
TV stations CPs—not on air	123	124	169
TV stations—new requests	17	16	16
A-M stations on air	2,748	2,732	2,592
A-M stations CPs—not on air	125	108	121
A-M stations—new requests	201	222	167
F-M stations on air	538	540	559
F-M stations CPs—not on air	17	12	12
F-M stations—new requests	4	6	5

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	June '55	May '55	June '54
Aeronautical	43,855	42,396	40,154
Marine	50,714	50,187	46,299
Police, fire, etc.	18,415	18,149	15,697
Industrial	24,845	24,347	21,598
Land transportation	7,668	7,579	6,891
Amateur	139,993	137,199	123,287
Citizens radio	12,334	11,816	7,054
Disaster	317	315	283
Experimental	625	619	586
Common carrier	1,950	1,934	1,635

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	May '55	Apr. '55	May '54
Prod. workers, comm. equip.	348,800-p	350,200-r	334,700
Av. wkly. earnings, comm.	$71.38-p	$70.98-r	$67.42
Av. wkly. earnings, radio	$69.25-p	$68.68-r	$66.08
Av. wkly. hours, comm.	40.1 -p	40.1 -r	39.2
Av. wkly. hours, radio	39.8 -p	39.7 -r	39.1

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	July '55	June '55	July '54
Radio-tv & electronics	484.8	508.4	351.2
Radio broadcasters	560.4	586.2	377.2

p—provisional; r—revised
nr—not reported

FIGURES OF THE YEAR

	TOTALS FOR FIRST SIX MONTHS 1955	1954	Percent Change	1954 Total
Television set production	3,828,793	2,845,147	+34.6	7,346,715
Radio set production	7,058,889	4,886,559	+44.4	10,400,530
Television set sales	3,202,005	2,805,760	+14.1	7,317,034
Radio set sales (except auto)	2,429,018	2,410,893	+ 7.5	6,430,743
Receiving tube sales	226,502,544	165,709,060	+36.7	385,089,458
Cathode-ray tube sales	4,914,024	3,957,238	+24.2	9,913,504

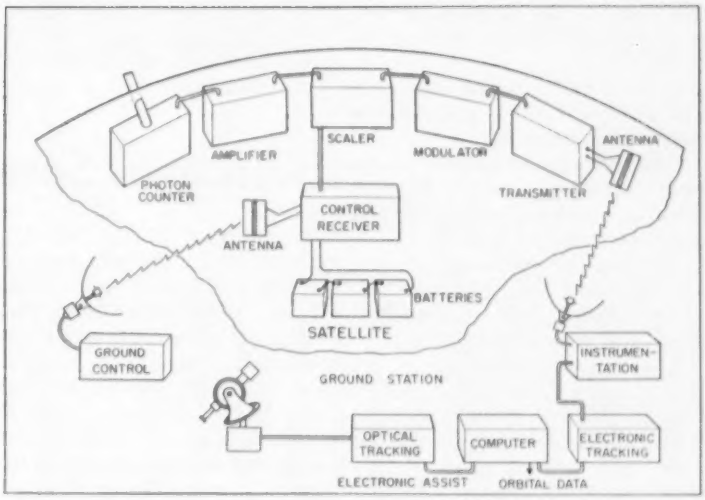
Transistor Tetrode Operates At UHF

OPERATION at frequencies exceeding 1,000 mc has been reported for experimental *npn* junction tetrode transistors produced by Bell Telephone Labs. Their high-frequency operation is achieved by reducing the central *p* layer to less than 0.0002 in. wide.

▶ **Other Units** – At least three companies, Germanium Products, Texas Instruments and Western Electric have transistor tetrodes commercially available. These are *npn* grown-junction units that work mostly at video and low vhf frequencies.

Transistors previously announced for the vhf and uhf regions include selected point-contact units (p 10, Aug. '52) operating up to 225 mc and the *pnip* transistor (p 18, Oct. '54) which oscillated at 440 mc and was expected to attain 3,000 mc. Other candidates for high-frequency transistor operation include surface-barrier transistors (p 12, Jan. '54) and the field-effect transistor or fieldistor.

UHF tetrode transistor



Educated guess as to how the first earth satellite may utilize electronic means of tracking and data reporting on command from the ground

Electronics Aids Space Station

Ten-million dollar project will swing reporting satellite at 18,000 mph

ALTHOUGH FOLLOW-UP stories predict greater space marvels after launching of the first earth satellite, announced recently by the President, scientists are puzzling just how to spend their multimillion government windfall most effectively. Techniques are known—in most cases proved—but will require careful dovetailing for greatest effectiveness and reliability in the first orbiter.

Scientists are surer, at this point, what they will not do rather than exactly how the job will be accomplished. They believe, for example, that dry batteries are a more reliable source of power than the solar batteries that will likely be employed in later satellites.

▲ **Why the Satellite?**—Projected as a part of the U. S. program of participation in the International Geophysical Year (1957-58), the 100-pound, basketball-like artificial satellite will be placed on orbit some 250 miles above the earth by rocket techniques. It will give unprecedented opportunities for scientific measurements of the upper atmosphere. Unlike a rocket, it will have a useful life expectancy of weeks, months or even years. The first may be limited to days or weeks. Out of approximately 90 minutes in which it will encircle

the earth, perhaps three to five will be available for experimentation.

The mass of electronic equipment used in launching and tracking the satellite, being similar to that used in military weapons, will probably remain classified information—when it is finally decided upon.

▶ **Educated Guessing**—Thinking aloud to an ELECTRONICS editor, John W. Townsend, Jr., assistant head of the Rocket Sonde Branch, Naval Research Laboratory, had a few ideas on the direction of proposed instrumentation. Some of his conclusions:

Mercury batteries and silver cells will probably power the satellite electronic equipment.

Telemetering and tracking equipment might be combined with tracking running continuously and instrumentation on and off.

Tracking can use low-power narrow bandwidth transmissions.

Telemetering will require full-power and wide bandwidth.

The switch between functions can be made with radio control from the ground.

Satellite instrumentation will include photon counters, Geiger counters, magnetometers, electrostatic analyzers, amplifiers and scaling circuits—about 40 pounds of gear.

The telemetering transmitter may be f-m, f-m/f-m and p-w/f-m.

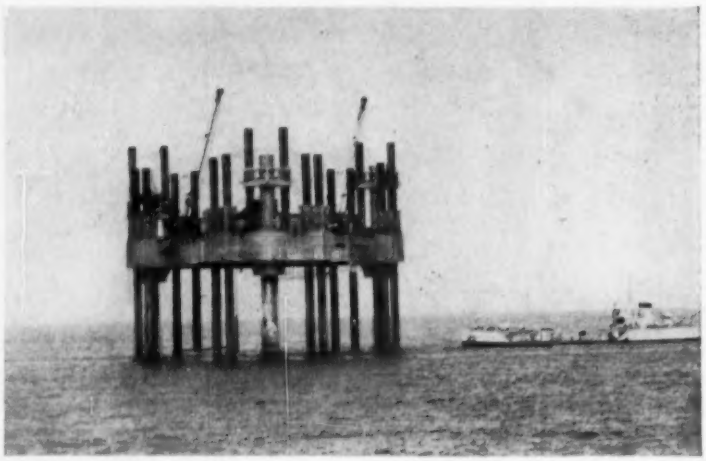
Tracking and ground command equipment may be conventional (and classified).

Computers will bulk large in maintaining accurate tracking of the bird.

High-accuracy optical tracking (when weather permits) will get an electronic assist by computing tracking measurements.

Computers will also indicate slowing up of the satellite and make possible measurements of retarding forces.

▶ **Route of the Bird**—If, as is expected, the orbit of the satellite is chosen over the equator (rather than over the poles) countries along the route will be able to track the orbit part of each 90-minute circuit.



CONSTRUCTION work is stepped up on Air Force Texas Towers as . . .

Hurricanes Speed Radar Islands

FIRST of the U. S. Air Force's steel islands for aircraft-detecting radar launched in May at Quincy, Mass., is now in place on Georges Bank, about 100 miles east of Cape Cod. Installation work was speeded in August when hurricanes Connie and Diane threatened the New England states. Cement work was completed while construction crews worked around the clock to make the island secure. Now electronic technicians are readying radar and radio equipment.

▶ **Equipment**—Rising from the platform will be three rubber radomes, each the size of a greenhouse. Each station will have height finders and a search radar. The height finders, type AN/FPS-6, manufactured by GE, have also been supplied to the Air Force for the ground radar network guarding the North American continent and are produced in a mobile version, the AN/MPS-14, for movement by trucks or heavy cargo aircraft.

▶ **Size**—The legs of the tower, reaching down to shoals along the continental shelf, will support a platform mounted 87 feet above water level, out of the reach of waves. The steel platform alone weighs 6,000 tons. It is the first of several similar towers to be erected along the east coast of the U. S. for the Continental Air Defense Command by the Navy's Bureau of Yards and Docks. The stations will be located approximately 100 miles off the coast and will be linked with the Continental Air Defense Command's shore-based warning network. Multichannel radio and radioteleprinter circuits will make use of new beyond-the-horizon propagation techniques. Each station will include housing facilities for a crew of 70 Air Force, Navy, Weather and Coast Guard personnel who will be stationed at the sites for 30-day periods or more.

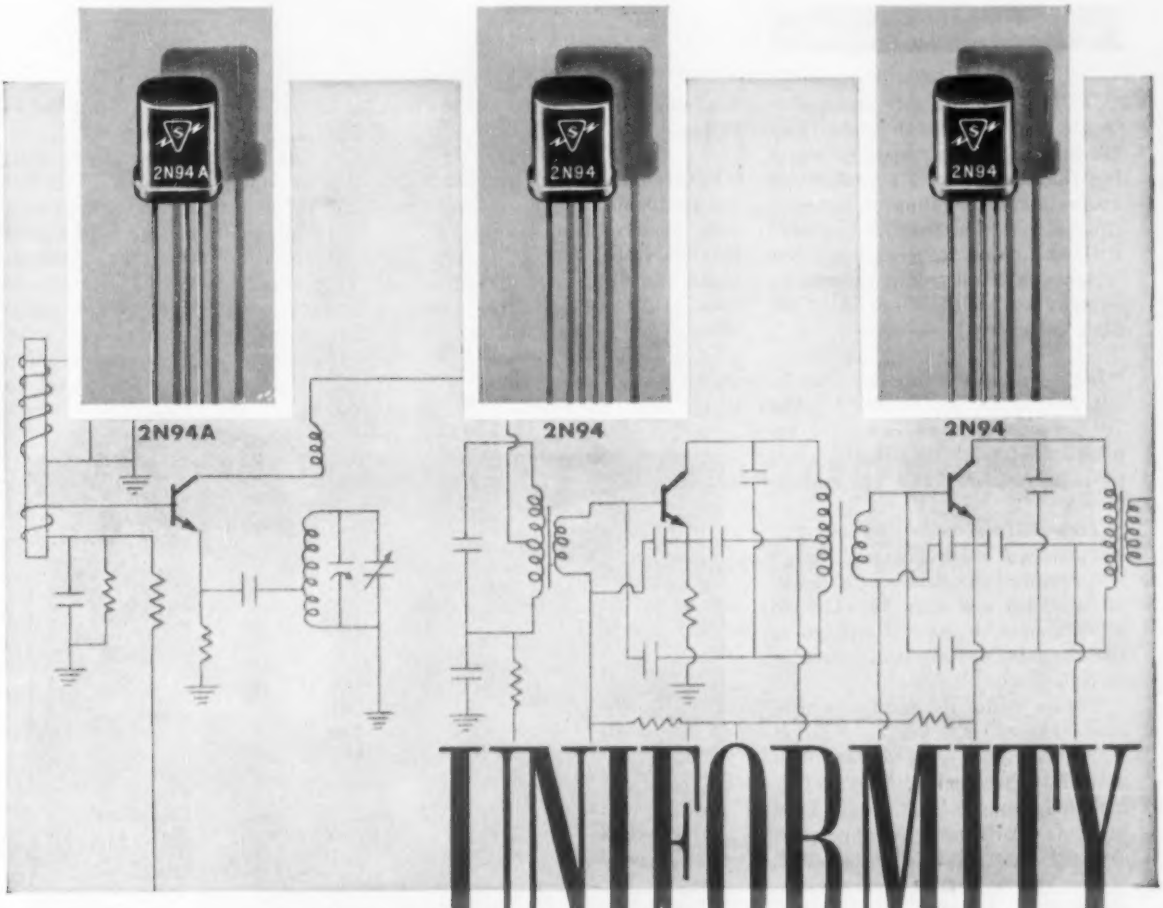
Computer Manufacturer Presses 1,000 Mark

IBM discloses sales, orders, and new developments in data processing machines

SALES for electronic data processing machines are approaching the 1,000 mark at International Business Machines Corp. The figure includes 31 machines of the one-million-dollar-plus 700 series delivered and another 150 on order as well as 80 smaller-sized model 650's installed and 700 on order.

▶ **Data Processing**—The term electronic data processing machine

(Continued on page 10



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...for more gain from stage to stage without preselecting

For your broadcast applications, Sylvania high frequency transistors Type 2N94 and 2N94A offer higher gain without preselection by stage. Production is simplified; performance is more stable; servicing problems are minimized.

Low collector capacitance and ease of neutralization account for this important advantage. In a typical broadcast application, the addition of a single 10 $\mu\mu$f capacitor in the collector circuit of IF and RF stages provides adequate neutralization.

Uniformity is obtained through unique construction techniques permitting close production control.

In computer applications Sylvania Transistors offer quick recovery time for high speed switching and provide higher gains at higher operating currents.

High Frequency Transistors
Type 2N94 (3 mc alpha cutoff)
Type 2N94A (6 mc alpha cutoff)
featuring
- high gain
- high uniformity
- low collector capacity
- ease of neutralization

Low Frequency—High Gain
Type 2N34 (PNP)
Type 2N35 (NPN)
—for low to medium power use. Gains up to 40 db in grounded emitter circuit

High Power—Low Frequency
Type 2N68 (PNP)
Type 2N95 (NPN)
—increased power ratings—to 2.5 watts. Use for high current, low voltage applications (6—24 volt power supplies)
Type 2N101 (PNP)
Type 2N102 (NPN)
Similar to types 2N68 and 2N95 without cooling fins. Power dissipation 1 watt.

For complete information on Sylvania Transistors write to Department 3208

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(EDPM) includes only those electronic computers with sophisticated internal programming—meaning they can run off a problem in business data handling or in scientific computation from A to izzard without human intervention. Not included are electronic calculators—really souped-up versions of the desk calculator.

▶**Big Fellows**—Nineteen model 701 computers are installed. The 701 is a large-scale computer especially designed for scientific computing. No more 701's will be produced.

This fall, six model 704 scientific computers of more advanced design will appear to replace a half dozen 701's which will then be assigned other chores. First 704 will go to the company's computation center in New York.

Twelve model 702 machines have been shipped. The 702 is a large-scale machine designed for business data processing. Users of it include Monsanto in St. Louis, IBM in New York and Poughkeepsie, General Electric in the Hanford, Wash. atomic energy works, Commonwealth Edison in Chicago, Pratt and Whitney in Hartford, Conn. and the Bank of America in San Francisco. The first 705—an advanced design business computer—is due this fall.

▶**Smaller Machines**—The model 650 is a medium-sized edpm available with both punched-card and magnetic-tape input and punched-card and printed output. It handles both scientific and business computations. Several companies have more than one: Lockheed has five and GE has four.

The model 305, an edpm using the juke-box type of random-access memory, is expected to join the line this fall.

▶**Other Developments**—A trend in large-scale computers is to magnetic-core memories. The models 704 and 105 use core memories for fast internal storage. Core memory is available for the 701.

Work on speeded-up input-output devices continues with a 1,000 line-per-minute printer soon to be available for model 700 series machines.

▶**Future**—Packaged programming for electronic computers is another area of development. Fortran, or formula translation, is a technique which translates engineering mathematical processes into machine language. Fortran will be available in January. Autocoder, which makes use of subroutines on magnetic tape to simplify business data handling, will be available in March.

Trend at IBM is towards a single line of edpm. Already the 702, 704 and 705 can communicate with each other. Actually machines designed for scientific work have successfully handled business problems and vice versa. At present applications run two-to-one in favor of engineering over business but this may change on the long haul to two-to-one business.

TARGET and mesh assembly of camera tube is formed under dust and lint-free conditions at GE plant while . . .

Orthicon Output Gets A Boost

Three manufacturers now are producing the tubes for the television broadcasters

▶WITHIN the past few months General Electric and Westinghouse have joined RCA as producers of image orthicons. Westinghouse began producing the tubes last May and GE production schedules call for shipments early this fall.

▶**Volume**—Assembling the 256 parts of the tube is one of the most difficult jobs in the tube business. It requires high dust and lint control standards and calls for expert handicraft. This accounts for the high cost of the tubes. Of the two types of image orthicons now being produced, the black-and-white studio camera tube sells for $1,200 and the color image orthicon has a $1,700 price tag. It is estimated that about 8,000 of the monochrome type are now in use and some 100 of the color type.

▶**Output**—Difficulty of producing the orthicon is indicated by the manufacture and installation of the target and mesh assembly. It consists of a copper mesh of 500 wires to the inch spaced two thousandths of an inch from a glass membrane called the target that is between one tenth and two tenths of a thousandths of an inch thick.

(Continued on page 12)

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HERE ARE THE SMALLEST *aluminum electrolytic capacitors ever made to Sprague's rigid quality standards.* Add to that their low leakage current, high reliability, and moderate price, and you have a new series of *miniature* electrolytic capacitors ideal for use in transistorized pocket radio receivers, wireless microphones, personal-style wire recorders, and similar equipment.

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Sprague Littl-Lytics are available in a full range of capacitance ratings from 1 to 110 mf, and in standard working d-c voltages of 1, 3, 6, 10, 12, and 15. Sizes range from 3/16"D x 1/2"L to 3/8"D x 3/4"L. Maximum operating temperature of the new Type 30D capacitors is 65°C.

Performance characteristics, sizes and ratings of metal encased, hermetically sealed Littl-Lytics are all in Engineering Bulletin 320, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

typical ratings

Cat. No.		30D6	30D16
WVDC		6	6
μF		3	60
Leakage Current (μA Max.)		2.0	3.0
Can Size	D"	3/16	3/8
	L"	1/2	3/4

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Productivity Gains In U.S. Industry

ANALYSIS of government statistics by the U. S. Chamber of Commerce indicates that American industry has increased the output of goods and services almost 30 percent since the end of World War II. The study estimates that from January 1946 to January 1954 the nation's output per man hour increased about 23 percent. For 1954, industry's productivity boost is estimated at four to six percent.

▶ **Gains**—Since 1929 average hourly earnings of factory workers have increased 104 percent compared to an increase of 97 percent in the average output per worker.

Army Buys Transistor Transceiver

FIELD tests are being made by the Signal Corps of a quantity of developmental f-m transceivers. The set, developed by RCA, is designed for communications over a quarter-mile range. Pocket-size, it consists of a receiver-transmitter, microphone-earphone, collapsible antenna and a battery in a 15-ounce assembly.

The transceiver contains 12 transistors and one tube. It incorporates an all-transistor superheterodyne receiver and a two-transistor, one-tube transmitter. Up to ten hours operation is provided with a single battery.

Any frequency between 45 and 50 mc can be preset. The design is adaptable for fully automatic production.

Helmet holds transceiver

OUTPUT of equipment such as this designed by Phillips Petroleum for a small AEC reactor will grow when . . .

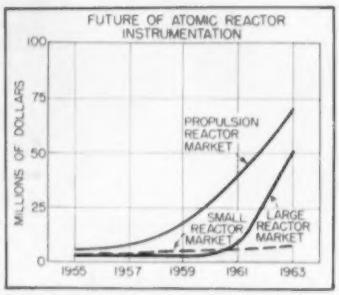
Reactors Expand Electronics

Projected growth in construction and use of power reactors bids to swell instrument volume

INCREASING use and development of atomic reactors in the U. S. in the next 9 years is forecast by the Atomic Industrial Forum. Its report shows that maximum reactor expansion may mean an annual volume of over $125 million in reactor instrumentation.

▶ **Major Markets**—As is shown in the chart, three markets for reactor instrumentation will be propulsion reactors designed primarily for naval craft and aircraft, small reactors or plants which include central-station plants having an electric output of less than 25,000 kw and central-station reactors above that output rating. Instruments for reactors used by AEC for weapons-material production are not considered.

Instrumentation sales for propulsion reactors are seen reaching at least $35 million and perhaps as much as $70 million by 1963. For large reactors instrument sales of at least $1 million are projected by

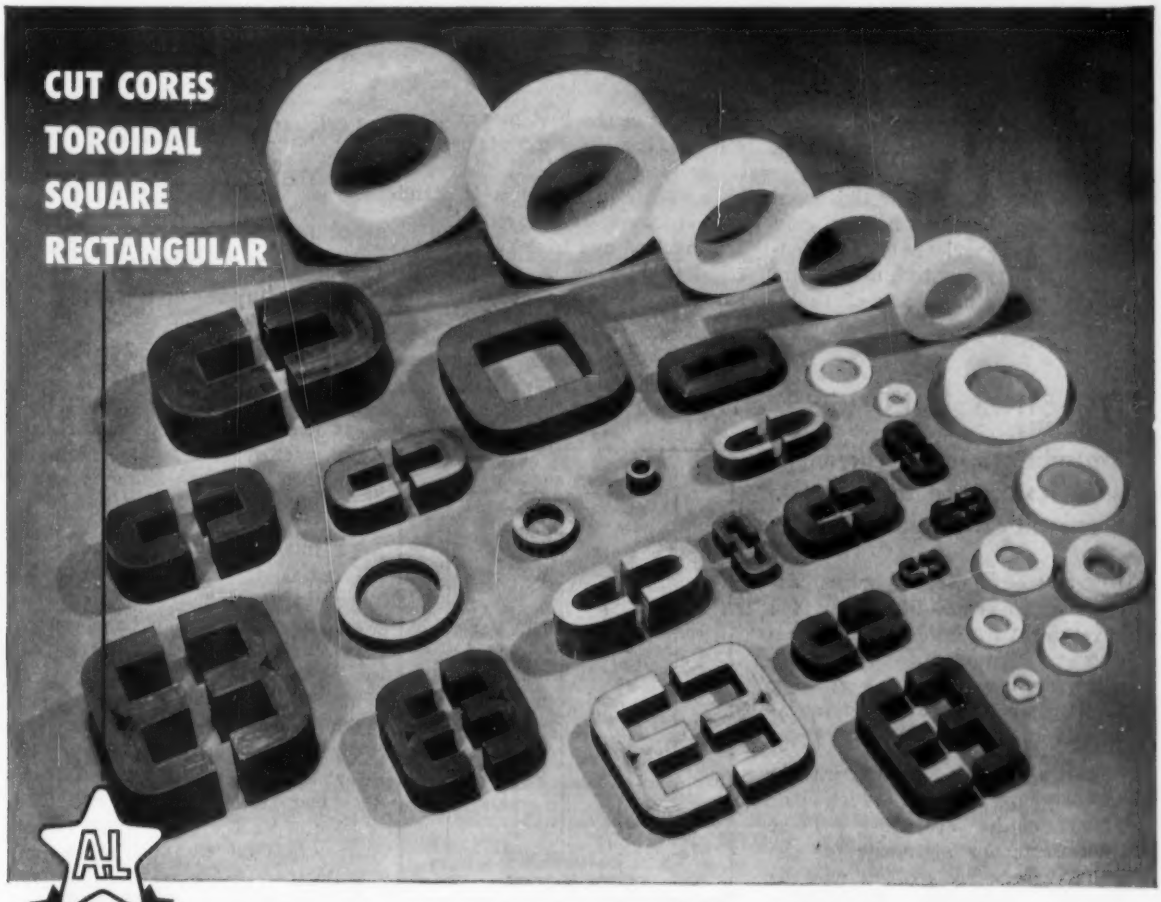


1963. However a maximum volume of $50 million could be attained by 1963 depending on commercial development. Small reactors are seen accounting for between $2 million and $7 million in instrumentation sales.

▶ **Future**—The percentage of the total cost of a reactor plant devoted to instrumentation will be reduced to one-half its present value as these plants progress from developmental to commercial stages. In pilot and experimental plants, designs are normally over-instrumented because of safeguards incorporated.

As experience grows, instrumentation for experimental purposes

(Continued on page 14)



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In most of the magnetic materials named, Arnold Tape-Wound Cores are produced in the following standard tape thicknesses: .012", .004", .002", .001", .0005", or .00025", as required.

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can be eliminated, control functions combined and made automatic and designs simplified.

Manufacturers of industrial-control instruments may have to gain some of the experience of radiation-detection instrument manufacturers to deal with the effects of radioactivity and the best means of instrumenting reactor systems. The majority of components of reactor-instrumentation systems is standard. However, some novel functions are involved and high reliability is required because of the potential hazards.

Missiles Business Shoots Up

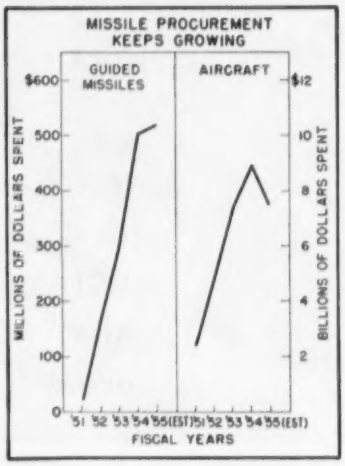
Expenditures for procurement grow faster than for aircraft. Electronics firms get share

DESPITE conflicting reports concerning the expenditures by the government for guided missile procurement, research and development, such weapons are growing in importance to the electronics industry.

▶ **Makers**—Prime contractors in the development and production of guided missiles are engaged in at least 27 separate projects for the military services, according to the Aircraft Industries Association. Manufacturers of electronic equipment among 20 known prime contractors of missiles include Bendix making the Loki, Western Electric with the Nike, Raytheon with the Hawk and Sparrow, Firestone with the Corporal, Eastman Kodak with the Dove, Sperry with the Sparrow, Philco with the Sidewinder and Hughes with the Falcon.

Magnovox recently announced that it had been awarded contracts for production of a new type of guided missile that has been under development for two years. Many other electronics manufacturers are also cashing in on the guided missiles program. Farnsworth Electronics Division of IT&T has received orders in excess of $10 million for substantial quantities of control and test equipment in connection with the government's guided missile program.

▶ **Status**—As shown in the chart guided missiles expenditures have outstripped spending for aircraft in rate of growth in the past five years. They have increased steadily



while aircraft expenditures have dropped back. However, in terms of overall dollar volume, aircraft expenditures are some 15 times greater.

In the field of research and development, guided missiles rank almost equally with aircraft in funds provided. For fiscal 1955, an estimated $254.1 million was obligated for guided missile research and development by the Defense Department compared to $263.0 million for aircraft and related products.

The Air Force is taking the lead as the largest procurer of guided missiles of the three services. In fiscal '55 it is estimated that Air Force will spend $258.5 million on the devices compared to $144.9 for Navy and $115.0 for Army. In 1954 and 1953, Army lead the services in missiles procurement.

Recent appointment of D. A. Quarles, former AT&T missiles expert, as Air Force Secretary also points up the weapon's growing importance.

What's Ahead For The Remainder Of 1955

Set manufacturers are optimistic but consumers plan to buy fewer tv sets

THE remaining months of the year have, in the past, accounted for as much as 45 percent of annual tv set sales and receiver manufacturers are, in the main optimistic about prospects. Some see improved profit margins.

▶ **Firms** — Hoffman Electronics' forecast for the fall months is healthy volume at a better price and profit level than has been experienced in the immediate past.

Motorola estimates that some 7.5 million tv sets will be sold during the year and estimates that some 4.4 million will be sold during the last half. The radio total was forecast at 12 million sets. For 1956, sales of another 7.5 million tv sets were forecast. By 1965 the company estimates that more than 65 million tv sets will be in use, with more than half of them color sets.

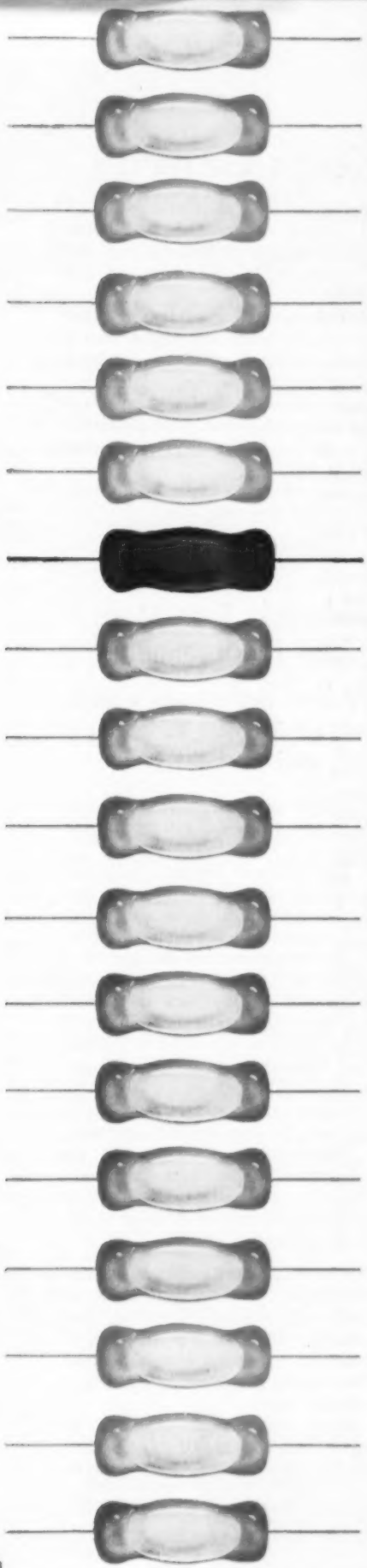
Philco looks forward to excellent tv business all during the fall season. With national income and employment at record levels, it expects consumer buying of all of its products to gain.

Sylvania estimates that this year net sales will total 7.2 million sets and may even equal last year's record of 7.3 million sets. The firm points out that in past years, strong tv sales sometimes ran counter to minor business turn-downs but that the industry has now come of age and is tied pretty tightly to the overall condition of the national economy.

Zenith expects that the normally stronger fall and winter market will permit a reversal of the trend toward lower prices and that a higher percentage of console receivers will be produced which will have the effect of substantially increasing average unit billing prices.

▶ **Down**—Despite the rosy outlook

(Continued on page 16)



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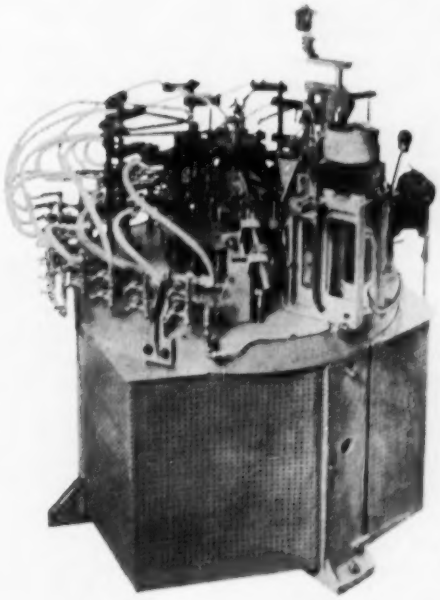

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CONTI

foreseen by some setmakers, the University of Michigan's latest survey of peoples intentions, taken in June, shows that although consumers plan to keep on buying houses, autos and appliances, planned purchases of tv sets appear to be lower than they were last year.

Analog Computers Help Design Brakes, Missiles

ONE of the largest analog computers will be installed at Wright Air Development Center, Dayton, Ohio. The million-dollar machine will be built by Reeves Instrument Corp., a subsidiary of Dynamics Corp. of America (ex Claude Neon). The computer's speed and capacity for solving differential equations will be utilized in development of weapons systems for the Air Force.

Overall design calls for an integrated computer organized in four separate sections. The computer will incorporate more than 500 operational amplifiers and will occupy 6,000 square feet. Design innovations include problem checking routines, automatic programming and visual indicators to pinpoint equipment malfunction.

▶ **Brakes**—A much smaller electronic analog is being used to design airplane tires in the B. F. Goodrich wheel and brake plant, Troy, Ohio. The instrument simulates the heat rise in an aircraft brake during landing. A 300,000-pound plane landing at 100 mph causes the temperature where the brake lining rubs the drum to rise to more than 2,000 F.

The analog solves problems relating to whether critical temperature ratings will be exceeded.

▶ **On-Line Control**—A Goodyear Electronic Differential Analyzer (GEDA) will take over automatic control of 35 steam electric generating plants for Ohio Edison Co. The equipment will be installed in 1956 at the company's central dispatching headquarters Massillon, Ohio. Carrier telephone will transmit control signals to the generators—some as far as 150 miles away.

Klystron Business Keeps Gaining

Manufacturers expand production capacity as increasing applications push sales

IT HAS been 17 years since the klystron tube was invented. In that time the tube has been responsible for millions of dollars in sales by its various manufacturers.

▶ **Business**—Sperry recently announced an order from the Signal Corps for 2K25 klystron tubes, totaling more than $200,000. According to the company, latest applications of the tube now extend to automatic control systems and target simulators for beacons, gun-fire controls, missile guidance and navigation devices in airborne, ground and shipboard service.

One firm estimates that industry wide in 1954 some 105,000 klystrons were produced at a value of between $11 million and $12 million.

▶ **Plants**—Sperry has begun production of high-power klystrons at its new $900,000 plant in Florida. Varian is constructing a new klystron plant in Canada and Marconi is also building a plant in Canada in which klystrons will be made.

▶ **Why**—Research and development on power-amplifier klystrons have permitted the transmission of direct tv signal and multichannel radiotelephone conversations beyond the horizon for distances up to 200 miles.

This research found that by using larger antennas and higher power such reception could be obtained. Resulting commercial and military microwave applications are expected to create substantial demand for the power klystron in the immediate future.

More than 40 types of klystron tubes are now available.

Viking 11 rocket takes a Varian V-55 reflex klystron to a record-breaking altitude of 158 miles. The tube was recovered in operating condition

Networks Plan More Color Programming

At least twelve hours a week will be colorcast during the last quarter of the year

SOME of the tv networks are setting new plans for color programming.

NBC plans to present nearly five times as many hours of color this fall as it carried last season. In October there will be 37 hours of live studio programming as against 7 hours last October. In November, there will be 41 hours as against 8.5 hours last year. December will have 38 hours compared to 9 hours last December. There will be outside pickups, such as the World Series and football games, mobile-unit pickups for 5 scheduled programs.

The network is expanding its color facilities with the construction of a color studio in Radio City and the installation of color equipment in another studio.

▶ **Plan**—CBS, which ran a rotation plan for colorcasting its black and white tv shows, completed this schedule June 9. For the fall, it plans to broadcast a minimum of two weekly programs in color on a regular basis.

The net has one theater in New York and its tv city in Cali-

(Continued on page 20)

NEW!

® Universal Z-Y Bridge

Measures Impedance . . .

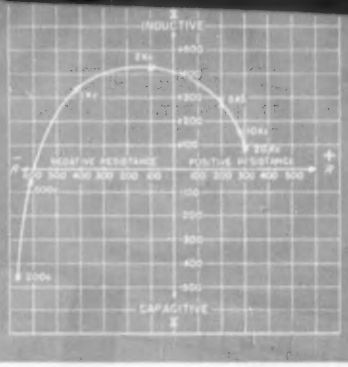
- ✓ from 0 to ∞ ohms
- ✓ balanced or grounded
- ✓ positive or negative
- ✓ at any phase angle
- ✓ over 20-cps to 20-kc range

The Type 1603-A Z-Y Bridge is the latest addition to the G-R line of precision impedance-measuring apparatus.

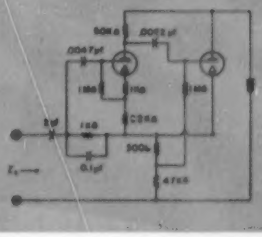
This Universal Z-Y Bridge will measure any impedance — from short circuit to open circuit, at small or large phase angle, and with a basic accuracy of 1% over most of this very wide range. Quadrature components of impedance, R & X or G & B, are measured directly at calibrated 100c, 1kc and 10kc bridge positions. Measurements at other frequencies over the 20 to 20,000 cycle range are made simply by multiplying reactance X or susceptance B readings by a factor which takes into account the difference between operating frequency and frequency setting of the Bridge selector switch.

The ability to measure impedances of any magnitude and with good accuracy with the same instrument can be an extremely valuable asset in many measurement situations. The Z-Y Bridge can be used by chemists for measuring conductivity of liquids in dielectric cells as readily as it can be used for ordinary R-L-C component measurements in the laboratory or production-test department. It will measure . . . open-and short-circuit transformer parameters . . . impedances of batteries and electrolytic capacitors . . . characteristics of audio-transmission networks . . . motional impedance of electro-acoustic transducers . . . Q and resonant frequency of chokes . . . and impedances of feedback loops, since negative real parameters are directly measured.

The Bridge also can be used to determine cable-fault locations and circular-arc plots of liquids or solids having lossy polarizations in the audio-frequency range. These are but a few of the countless applications for this unique and versatile device. *You name it — this Z-Y Bridge can probably measure it!*



Plot of Impedance Z_1 of Feedback Circuit . . . . illustrates ability of the Z-Y Bridge to measure any impedance; quadrature components may be positive or negative, real or imaginary.



SPECIFICATIONS

Frequency Range — 20 cycles to 20 kc

Impedance and Admittance Range —
R: ±1000 ohms G: ±1000 μmhos
X: ±1000 ohms B: ±1000 μmhos

Accuracy —
R or G: $\pm(1\% + [1 \text{ ohm or } 1\ \mu\text{mho}])$
X or B: $\pm(1\% + [\frac{f_0}{f} \text{ ohm or } \frac{f}{f_0}\ \mu\text{mho}])$
f is operating frequency, f_0 is frequency setting of panel selector switch

Impedances of less than 100 Ω (or 100 μmhos) can be measured on "Initial Balance" dials with considerably greater accuracy —
R or G: $\pm(1\% + [0.2\frac{f_0}{f} \text{ ohm or } 0.2\frac{f}{f_0}\ \mu\text{mho}])$
X or B: $\pm(1\% + [0.2\frac{f_0}{f} \text{ ohm or } 0.2\frac{f}{f_0}\ \mu\text{mho}])$

Maximum Applied Voltage — 150 volts, rms

Accessories Recommended —
Type 1210-B Unit R-C Oscillator and
Type 1212-A Unit Null Detector

Accessories Supplied —
2 Shielded Cables for generator and detector

Dimensions — 12½" x 13½" x 8½"

Net Weight — 21½ lbs.

Type 1603-A Z-Y Bridge — $335.00

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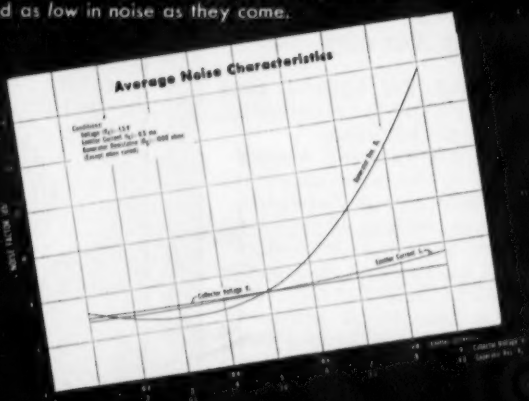
Type 2N133

Important Characteristics—Grounded Emitter (30°C)

Current Amplification Factor (Ave.)	50
Power Gain* (Ave.)	38db
Noise Factor† (Ave.)	6.5db
Noise Factor† (Max.)	10db

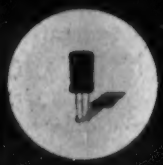
*Source: 1000 ohms; Load: 20,000 ohms
†in a one-cycle band at 1000 cycles
Above characteristics obtained with Vc — 1.5 volts; Ie 0.5 mA

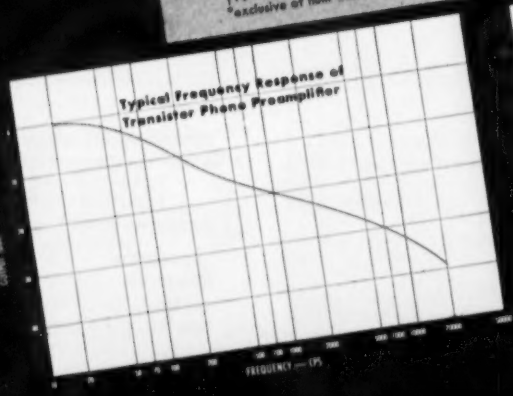


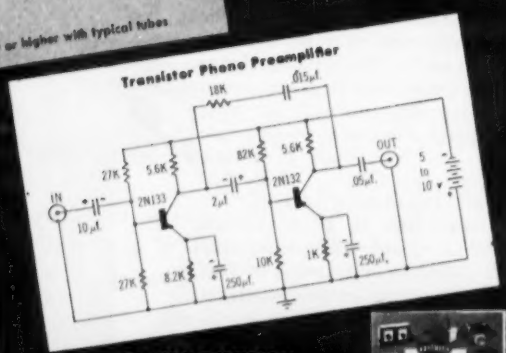
Typical Low Noise Application PHONO PRE-AMPLIFIER

	Vacuum Tube	Transistor
No. of Stages	2	2
Type of Response	RIAA	RIAA
Gain (1KC)	32db	44db
Tube	1: 6SC7	
Transistors		1: 2N133 1: 2N132
Signal Output†	0.4v	1.6v
Noise Output	100μv*	200 μv
S/N	72db	78db

†10 millivolt signal from reluctance cartridge
*exclusive of hum which may average 500 μv or higher with typical tubes







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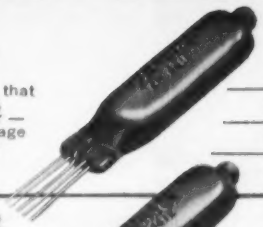
for all military and commercial portable, battery operated electronic equipment

— developed under U. S. Signal Corps contract

— backed by Raytheon's unequalled technical skill and engineering experience in the design and production of filamentary subminiature tubes

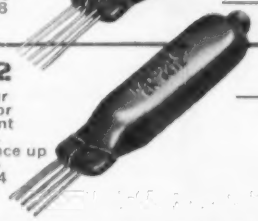
CK6611

a new IF amplifier, for 20 mc or more that requires 50 to 60% less filament power — 30% less plate voltage than present types 1AH4 and CK5678



CK6612

a new RF amplifier good for 100 mc or more, with filament power down 20%, mutual conductance up 50% compared to present type 1AD4



Type	Filament Current at 1.25V mA	Plate and Screen Volts	Mut. Cond. μmhos	Plate mA	Grid Plate Capacity μμf (max.)
CK6611	**20**	**30**	**1000**	**1**	**0.007**
1AH4	40	45	750	0.75	0.01
CK5678	50	45	820	0.8	0.01
CK6612	**80**	**30**	**3000**	**3**	**0.01**
1AD4	100	45	2000	3	0.01

Both these new tubes offer the following advantages:

- *long* life expectancy
- low filament and plate power permit smaller and lighter batteries
- mechanical ruggedness
- oxide coated tungsten filaments — a feature of *all* Raytheon filamentary subminiatures
- metallic shield coating over entire bulb
- *better* performance with less operating power
- Raytheon's flat press seal — The Seal of Reliability

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Special Tube Division

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For application information write or call the Home Office or:
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[illegible] Fifth Avenue, New York 17, New York, PLaza 9-[illegible]
[illegible] South La Brea Ave., Los Angeles 36, Calif.,
WEbster 8-[illegible]

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RELIABLE SUBMINIATURE AND MINIATURE TUBES
SEMICONDUCTOR DIODES AND TRANSISTORS
NUCLEONIC TUBES • MICROWAVE TUBES
RECEIVING AND PICTURE TUBES

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fornia equipped for color. In addition, it is refurbishing quarters in Chicago for tv studios which will be equipped for colorcasts.

▶**Stake**—American Broadcasting, which is the only tv network without a stake in color set manufacturing, has no immediate color telecasting plans. According to a network spokesman, AB-PT will have color ready when there is enough set saturation. As of now, the network has no color studios in operation. However, three of its leading shows for next fall, Disneyland, Warnerland and the Mickey Mouse show for children, are being photographed in color.

Du Mont which now only has owned and operated stations in York and Washington, D. C., is planning a heavier color schedule for its New York outlet. It plans to continue the present Sunday night one-hour color show throughout the rest of the year. It will also relocate color equipment in its Telecenter so that frequent use can be made of it throughout the day especially for station breaks.

A new program series of short subjects, will show color films as they are available. It is expected that the company will also push color programming with its new Electronicam tv-film system and Vitascan equipment.

Industry Shows Mixed Record

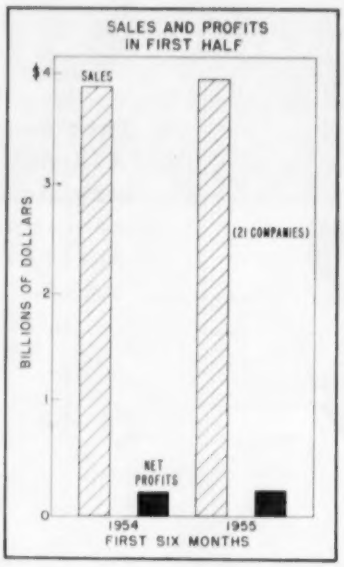
Sales and profits soar for some companies but others have sharp declines

WITH television receiver production up 34 percent in the first six months of this year over the same period in 1954, and with radio output up 44 percent, companies in the radio tv end of the electronics industry would seem to be in fine shape. Many have experienced record sales and profits in the first six months of this year but a number of important companies show up poorly in first-half financial reports.

▶**Bullish**—Total sales of 21 representative companies increased from $3.8 billion to $3.9 billion while profits increased from $226 million to $233. See chart.

▶**Bearish**—Sales increases for individual companies were as high as $44 million. Profit increases ranged up to $8 million. But decreases in sales and profits of some other companies overshadowed gains. A decline of $54 million in sales and $16 million in net profit was experienced by one firm. Declines were attributed to lower defense volume, increased competition and lower profit margins.

▶**Check**—A survey made by the First National City Bank of New York of radio-tv electrical equipment companies also showed the financial spottiness of the industry. Despite large gains by some firms, others showed substantial declines so that the overall net change in 1955's first half was small compared to 1954. Total sales increased only 2 percent while profits showed a one-percent decline.



Sales totalled $3.2 billion in the first half of 1954 compared to $3.3 billion this year. Net profits were $172 million in '54 as against $170 million this year.

Electronics Withstands Nuclear Explosion

Equipment ranging from antenna towers to vacuum tubes holds up well

EVALUATION of damage to some 150 electronic products exposed to the nuclear explosion at Yucca Flats revealed nearly all items operable or readily reparable. Various pieces of equipment were housed in dwellings in situations approximating normal conditions and at distances of 4,700 and 10,500 feet from the blast. While the buildings were damaged by the blast, the electronic equipment showed good durability. Damage was due almost wholly to falling debris. Radiation was not a problem and thermal damage was insignificant. No broken vacuum tubes or tv picture tubes were observed.

▶**Station**—A 250-watt radio transmitter, housed in a building which was heavily damaged, came through unscathed but went off the air when power lines to an outside gasoline generator were snapped by falling utility poles. The broken lines were repaired in less than 15 minutes. Power failure could have been avoided by underground wiring. Three steel antenna towers were still standing after the blast. The explosion had virtually no effect on the a-m station's antenna tower, but snapped a small one erected for a nearby mobile radio station. The stations were 4,700 feet from blast center.

▶**Mobile**—The house in which one radio station was installed was demolished, and station equipment hurled from the second floor to the top of a pile of debris at ground level. However, the equipment was operable when inspection teams arrived on the scene. A radio-equipped auto parked outside the transmitter building was badly wrecked but its two-way radio remained operable. In a second car, 10, -500 feet from blastcenter, the radio was untouched.

(Continued on page 22)

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Under the cumulative shock of rocket-boosted zero-length take-off, jet-fighter flight maneuvering, and on-target dive that cracks the sound barrier, the nation's first operational pilotless bomber relies on ALL-ANGL Barrymount® isolators to protect critical electronic control gear.

Equally effective in every flight attitude, ALL-ANGL mounts permit bulkhead mounting that saves vital space in this deadly weapon. And their proved performance makes Barry mounts Martin's choice for the Matador

Let us show you how Barry's new ALL-ANGL isolators can lick *your* tough mounting problems. Data sheet M-9 gives mechanical and dynamic specifications. For specific recommendations, call your nearest Barry Sales Representative.

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More Auto And Parts Firms Feature Electronics

Other automotive concerns diversify by adding lines of electronic products

STUDY of corporate structures of automobile and parts manufacturers reveal other firms engaged in electronics manufacturing and development in addition to the fifteen previously reported (ELECTRONICS, p 12, Aug. '55). There are probably even more companies whose lines include both electronic and automotive products.

▶ **Other firms**—Willys Motors, which made electronics news when it introduced the flat television tube, has three divisions engaged in electronic work.

Bendix Aviation, manufacturers of automotive and aircraft parts, makes a wide range of electronic products from computers and guided missiles systems to radio and television sets. Arvin Industries makes auto heaters, mufflers and other parts and is in the radio-tv business.

Electric Auto-Lite, which manufactures ignition systems, also produces electronic items. Sterling Precision Instruments makes radar, guided missile and fire control equipment through its Trans-America Precision Instrument Corp. Sterling, a manufacturer of gas and diesel engines has announced intention to acquire American-La France-Foamite, a fire-truck manufacturer. ACF Industries includes ACF Electronics, Avion Instrument and the Carter Carburetor Corp.

▶ **Tire Makers**—The Goodyear Tire and Rubber Co.'s subsidiary Goodyear Aircraft manufactures computers and military electronic products. General Tire and Rubber is in electronics through its interest in General Teleradio. B. F. Goodrich developed its own analog computer used in designing aircraft tires.

▶ **Diversification**—Several highly diversified companies make electronic products and automotive products. Sperry-Rand includes the Waterbury Tool division of Vickers which makes hydraulic variable speed transmissions and Tulsa Winch whose products are used on trucks and tractors. Baldwin-Lima-Hamilton's line includes street cleaners and earth-moving equipment as well as the SR-4 strain gage and other test and measuring equipment. Allis Chalmers' line includes tractors and ignitrons.

Educational TV Plans Big Year

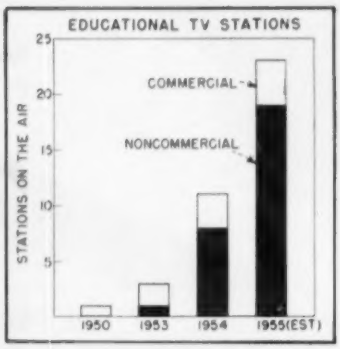
Number of stations going on the air this year will double the size of the service

SO FAR this year a total of eight new educational tv stations have gone on the air and by the end of the year the number is expected to reach a dozen. This will bring the total number of tv stations operated by educational institutions to 23.

▶ **Breakdown**—According to the Joint Committee On Educational Television, additional noncommercial educational tv stations that are expected to be on the air within the next few months are WAIQ, channel 2 in Andalusia, Alabama; WOSU-TV, channel 34 in Columbus, Ohio; WTTW, channel 11 in Chicago, Illinois and a station on channel 56 in Detroit, Michigan.

Of the 23 stations operated by educational institutions, 17 are operating on channels reserved for educational tv. Two stations, KWAR-TV and KUON-TV, operate noncommercially on channels not reserved for educational tv. Four tv stations, WOI-TV, KOMU-TV, WBAY-TV and WNDU-TV, are operated by educational institutions on commercial channels.

▶ **Cost**—The 17 educational tv stations on reserved channels have spent a total of $5.1 million in establishing the stations. Average cost for setting up an educational station is $305,000. However, cost varies over a wide range because of donations and other factors. For example, the lowest establishment cost for a station on the air is that of WBIQ, channel 10 in Birmingham, Alabama which spent only $500. The transmitter, tower, land and building were donated by commercial station WBRC-TV for $1.00 per year. This includes use of studios, cameras and slide/film camera units for 1.5 hours per day.



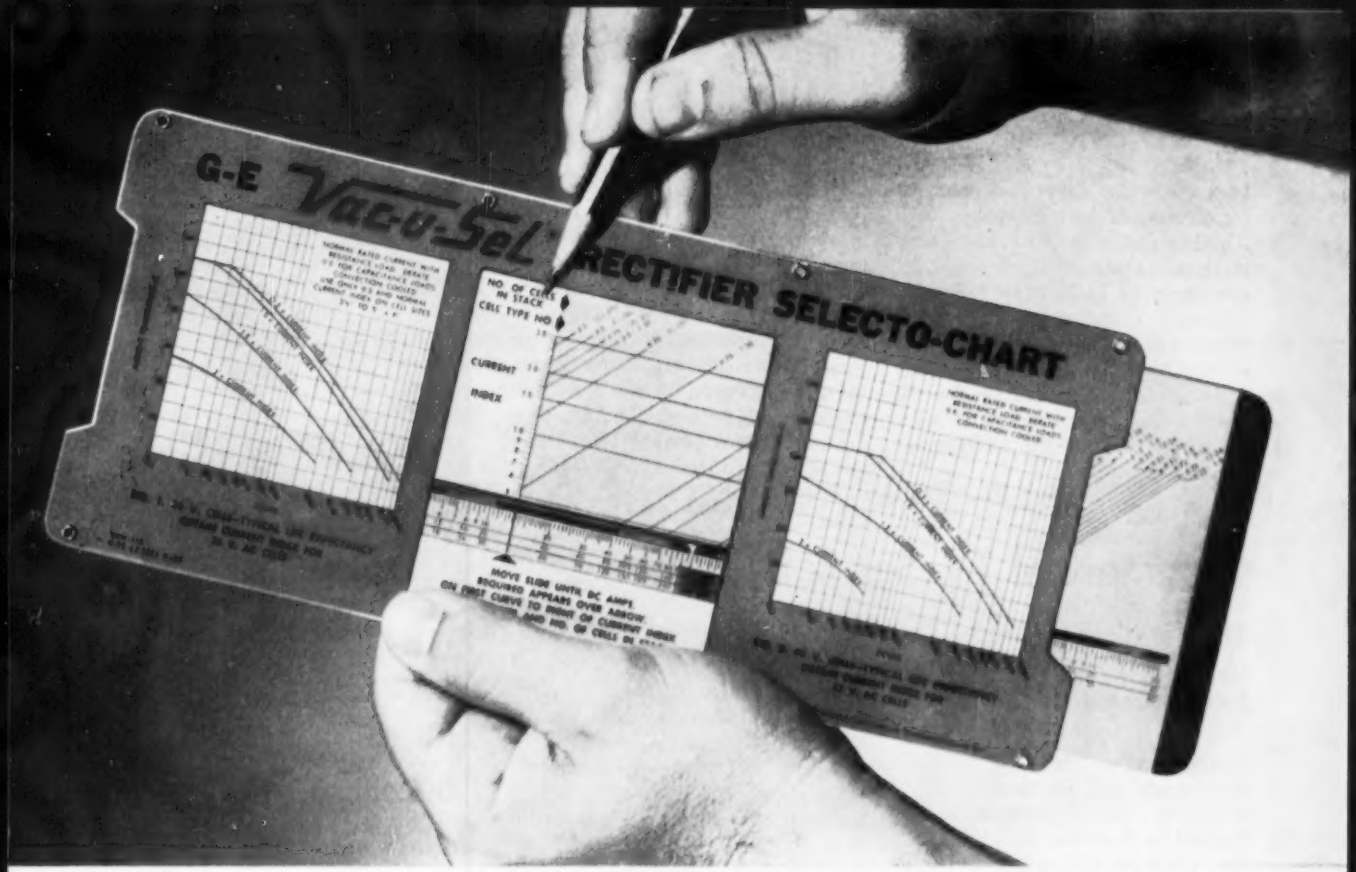
On the other hand, WUNC-TV, channel 4 in Chapel Hill, N. C., estimates its cost at $1,020,000. Nearly all tv transmitter manufacturers have sold equipment for educational tv use.

Taped Music Has Sound Future

PRERECORDED tape, as a consumer item, has not been keeping pace with the growing use of tape recorders in the home. On the other hand, eight-hour tapes of mood music have taken over almost exclusively in the background music field.

Loading difficulties, awkwardness in handling short selections and the danger of accidental erasure are disadvantages that have

(Continued on page 24)



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GENERAL ELECTRIC

been listed for tape as a competitor to disks in the home music field. Another factor is the cost of base material—about 19 cents for disks compared to $1.00 plus for tape.

Present home sales average from 300 to 800 copies of each selection, most of these going to high-fidelity enthusiasts. The saturation for the prerecorded tape market is estimated at from 3,000 to 4,000 copies per selection.

Background Music—The five largest suppliers in the background music field are using 8 to 12 hour tapes to supply music to their subscribers. The Muzak Corp. provides music service to over 20,000 subscribers from a tape library of more than 7,000 selections. Three firms, the Ampex Corp., Presto Recorder Corp., and Magnecord Inc. are producing the long-playing reproducer units used in these installations.

Commercial TV Set For Britain

Three stations will be on the air by next March. Sets are being adapted for the service

EXPERIMENTAL broadcasts have been made and on September 22 Britain's first commercial tv located at Beaulieu Heights Croydon, a suburb of London, will start transmitting programs.

By March of next year two other commercial stations will open in the Midlands and in Lancashire. The three stations will bring almost 60 percent of the total population of the United Kingdom within reach of commercial tv.

▶ **Sets**—About 1.2 million of Britain's 4.7 million tv receivers will be equipped to receive the new service. For the past year tv set makers in Britain have been selling receivers that can receive the new commercial stations as well as the BBC. It is estimated that about 1 million of these are now in use.

By the time the first stations go on the air this month some 200,000 one-channel sets will have been converted to receive the commercial channel. Conversion cost is estimated at 10 pounds, about $28.

▶ **New Agency**—The Independent Television Authority or ITA is responsible for the new commercial service. It was set up in August of 1954 by an Act of Parliament and has a statutory life of 10 years. Its main functions are to own and operate transmitting stations. Programs will be supplied by privately financed companies which will work under long contracts with ITA.

▶ **Cost**—The Authority is allowed to borrow up to $5.6 million from the British Government within the first five years of its life but only $2.8 million of this can be drawn during the first year. The entire amount must be repaid before the end of 1964.

Microwave Relay Business Stirs

AFTER three years of comparative inactivity, microwave radio relay again breaks into the news albeit in a smaller way than the mammoth transcontinental systems.

▶ **Million Dollars**—Collins Radio will put in a million-dollar system for Continental Pipe Line Co. and Sinclair Pipe Line Co.—joint owners.

The system will link Houston, Texas and Ponca City, Okla. and will require two terminals and 25 relay stations. It is designed to carry 120 simultaneous conversations.

▶ **New Band**—A microwave system to use the relatively unused 2,450 to 2,700-mc band will be installed by RCA for Union Oil Co. in Los Angeles. Covering about 40 route miles, the system will link the company's control center, a pumping station and a branch office. Services provided will include voice communications, control and telemetering.

GE physicist uses modified snooperscope on silicon ingot as . . .

Infrared Scopes Go Commercial

Wartime snooperscopes and sniperscopes are moving into civilian fields

ABOUT 1,000 to 1,500 infrared viewers, commercial versions of the wartime sniperscope, are in use, according to Farnsworth Electronics division of IT&T. The number is relatively small because the instruments have only recently been made available for civilian application. The units are compact and portable, weighing approximately 10 pounds and cost $500 to $1,000 depending on the quality of design as well as the optics supplied.

▶ **Applications**—Film manufacturing and processing laboratories use the scopes to monitor film manufacturing operations in darkness. Nearly 200 are distributed among three major film firms.

The instruments are finding increasing use in security applications. Police prowl cars use them to examine suspects in darkness from the patrol car. A model is available that operates on the power from a car's cigar lighter.

In the general industrial field the devices are used in determin-

(Continued on page 26)

Exceptional stability
Ruggedized construction (sectionalized)
Instrument type tuning with SCANSPREAD*
In communications receivers—
The Pay-Off is on Performance!
Uniformly high sensitivity and ultra-high signal-to-noise ratio
High Image Rejection ON ALL 6 BANDS
Continuously calibrated bandspread OVER THE ENTIRE RANGE
Frequency readings to 1 part in 5000

You buy a communications receiver for just one thing—dependable performance. It's performance that counts, and the *NEW* Pro-310 was designed with performance in mind. It outperforms all the other receivers in its class. Here's why—

- **3 years engineering and design time in its development (including 1⅓ years to iron out the 'bugs') plus 5 years production experience on its military counterpart.**
- **The features shown above.**

Check on the NEW Pro-310—it's made to order for your "tough-spot" service. Write for specs and other details to The Hammarlund Manufacturing Co. Inc., 460 West 34th Street, New York 1, N.Y. Ask for Bulletin. No. E-9.

*Completely new concept in precision electro-mechanical bandspread.

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ing temperature distribution at heats above 250 degrees C and in warehouse surveillance.

In the identification of forgery, such as when an original signature has been mutilated or erased and written over, the instrument has proved particularly useful. This has been true especially in the identification of old oil paintings.

Medical applications include psychological and psychiatric study when it is desired to study a subject under conditions of complete surprise to stimuli.

The scopes have also been used, as has been done in the military (Nancy equipment), for signaling over long distances on land or sea. Standard sensitivity is 1 candle power at 1 mile. With a pulsed infrared light source, signals are good for ten miles day or night.

Financial Roundup

PROFIT reports made in the past month by manufacturers in the electronics field indicate the business conditions in the industry. Following are the net profits of manufacturers for the fiscal periods indicated:

Company	Net Profit 1955	1954
Admiral 6m	$1,946,192	$2,558,850
American Bosch Arma 6m	1,458,017	1,411,965
American Broadcasting Paramount Theaters 6m	3,438,000	1,850,000
Ampex 12m	365,736	25,691
Avco 6m	447,983	3,106,481
Clevite 6m	2,672,957	1,646,758
Con. Engineering 6m	295,961	467,143
Cornell-Dubilier 6m	1,381,448	1,012,280
Du Mont 6m	*1,249,000	479,000
Fairchild Camera 6m	638,000	757,669
General Electric 6m	101,892,000	93,856,000
GPE 6m	2,173,654	2,541,652
Hallicrafters 9m	363,438	*1,029,935
Hoffman Electronics 6m	419,179	818,683
IBM 6m	23,870,992	21,600,314
Int'l Resistance 6m	323,290	123,080
IT&T 3m	5,253,846	4,855,103
P. R. Mallory 6m	1,192,984	313,383
Minn. Mining 6m	15,781,268	11,453,133
Pacific Mercury 12m	255,817	196,015
Packard Bell 9m	362,131	334,849
Philco 6m	3,575,000	1,735,000
RCA 6m	22,061,000	19,268,000
Raytheon 12m	4,531,561	3,523,316
Reliance Electric 3m	574,828	480,577
Standard Coil 6m	*88,892	1,358,996
Stewart-Warner 6m	2,810,383	1,511,560
Sylvania 6m	6,088,019	3,522,785
Thompson Products 6m	14,791,093	14,213,253
Tung Sol 6m	1,528,792	1,001,537
Westinghouse 6m	29,417,000	45,359,000
Zenith 6m	3,126,061	1,288,246

*loss

FUTURE MEETINGS

AUG. 26-SEPT. 4: Great German Radio, Gramophone and TV Exhibition, Dusseldorf, Germany.

SEPT. 12-16: Tenth Annual Instrument Conference & Exhibit, ISA, Shrine Exposition Hall and Auditorium, Los Angeles, Calif.

SEPT. 14-16: 1955 Annual Meeting of the Association for Computing Machinery, University of Penn., Philadelphia.

SEPT. 14-16: Second Annual Meeting of Professional Group on Nuclear Science, IRE, Center Theater, Oak Ridge, Tenn.

SEPT. 17: Symposium on Automation, Cedar Rapids IRE, Cedar Rapids, Iowa.

SEPT. 23-24: IRE Fifth Annual Fall Symposium On Broadcast Transmission Systems, Hamilton Hotel, Washington, D. C.

SEPT. 26-27: RETMA Symposium, Electronics For Automation and Automation For Electronics, Philadelphia.

SEPT. 26-27: Sixth Annual Meeting and Conference of the IRE Professional Group on Vehicular Communications, Multnomah Hotel, Portland, Ore.

SEPT. 26-28: IRE Symposium, Aeronautical Communications —Civil and Military, Utica.

SEPT. 28-29: Industrial Electronics Conference, AIEE, Rackham Memorial Auditorium, Detroit, Mich.

SEPT. 29-30: Fall Assembly Meeting of the Radio Technical Commission for Aeronautics, Hotel Statler, Washington, D. C.

OCT. 3-5: National Electronics Conference, Hotel Sherman, Chicago, Ill.

OCT. 3-7: AIEE Fall General Meeting, Morrison Hotel, Chicago, Ill.

OCT. 10-12: The Eighth International Systems Meeting, Systems & Procedures Association of America, Cadillac Hotel, Detroit, Mich.

OCT. 12-15: 1955 Convention of the Audio Engineering Society concurrent with the Audio, Fair, Hotel New Yorker, New York, N. Y.

OCT. 17-19: RETMA Radio Fall Meeting, Hotel Syracuse, Syracuse, N. Y.

OCT. 20-22: Eighth Annual Gaseous Electronics Conference, GE Research Lab., The Knolls, Schenectady, N. Y.

OCT. 24-25: First Annual Technical Meeting, IRE Professional Group On Electron Devices, Shoreham Hotel, Washington, D. C.

OCT. 25-27: International Conference on Electronic Digital Computers and Information Processing, Darmstadt, Germany.

OCT. 28-29: 1955 Symposium of Philadelphia ISA, Penn Sherwood Hotel, Philadelphia, Pa.

OCT. 21-Nov. 1: 1955 East Coast Conference on Aeronautical and Navigational Electronics, IRE, Lord Baltimore Hotel, Baltimore, Md.

Industry Shorts

► **Production** of germanium transistors was temporarily suspended by Radio Receptor because it finds that the demand for the devices has not yet reached sufficient proportions to make limited production of a low-priced, high-quality product feasible.

► **Two** all-transistor portable radios, one with six transistors and the other with seven, will be introduced by RCA during the fourth quarter. The sets will both sell for $79.95.

► **Release** of information by ANDB on TACAN follows declassification from military confidential status.

► **Transistor** factory employing nearly 700 workers has been opened by Philips in Nijmegen, Netherlands.

► **National** Radio and Television Week, which starts September 18, will signal the start of a two-fold campaign by the industry to promote set sales and increase radio listening and tv viewing.

► **Five**-cent credit will be given to radio and tv technicians and servicemen by Philco Corp. for each old tube it receives. Returned tubes will be destroyed as part of the firm's campaign to break racket of reselling worn-out and discarded receiving tubes.

► **Growth** in the annual unit production of transistors has been estimated by one major manufacturer as follows: 1955, 1.5 million; 1956, 6.0 million; 1957 9.4 million.

KAY

COLOR BAR GENERATORS

for

Design • Production • Service

Designed to produce black and white and standard NTSC colors—green, yellow, red, magenta, blue and cyan—for receiver alignment and servicing, the Kay CHROMABARS may be used, without auxiliary equipment, to feed black and white and the six standard colors directly into the video amplier.

In combination with the Kay MEGA-PIX Single Channel, the CHROMABARS may be used to check overall performance of television receivers.

The *Chromabar* Model Multi-Chrome

Output Signal:

Colors: 1. Black, white and six NTSC colors 2.I, Q, R-Y, B-Y are available by switch selection.

Frequency: Video, RF output can be supplied through Mega-Pix at specified channel.

Polarity: Positive or negative.

Amplitude: Continuously variable, 0 to max. of 1.4 volts peak-to-peak across 75 ohms. Amplitude increases with impedance.

Phase Angle Accuracy: Within 3 degrees.

Repetition Rate: Continuously variable through range of ±5% about 15.75 kc.

Power Supply: 105-125 volts, 50-60 cps, 220 watts. Power supply electronically regulated.

On special order, RF oscillator can be added to provide RF output.

Price: $850.00, f.o.b. factory.

THE *Chromabar* MODEL UNI-CHROME

Output Signal:

Colors: All six NTSC standard colors available individually with black and white. Controlled by single front panel switch.

Other specifications similar to Multi-Chrome

Built-in dot generator for checking convergence and linearity.

Price: $425.00, f.o.b. factory. (Additional colors, gray shades or I and Q, R-Y, B-Y at $20.00 each.)

KAY *Chromadot*

Color Bar—Dot—Horizontal and Vertical Sync Generator

The CHROMADOT is a combined color bar dot generator with vertical synchronization so that only a single connection is required to the RF antenna or video amplifier. No connections are required to receiver sync circuits.

SPECIFICATIONS

1. Ten color bars progressive every 30°.
2. Reference color burst. Constant color across each bar.
3. Single dot per line in uniform pattern for checking convergence.
4. Varying luminance signal, plus 60 cycle vertical sync pulse for checking chroma circuits.
5. Positive and negative horizontal and vertical sync provided for stationary patterns without internal connection to receiver.
   Video: 0.6 volts peak to peak. 10 volts into 5000 ohms.
6. RF: 0.2 volts into 75 ohms or 300 ohms on any specified channel.
7. Sound carrier provided for tuning the receiver.

Price: $395.00, f.o.b. factory.

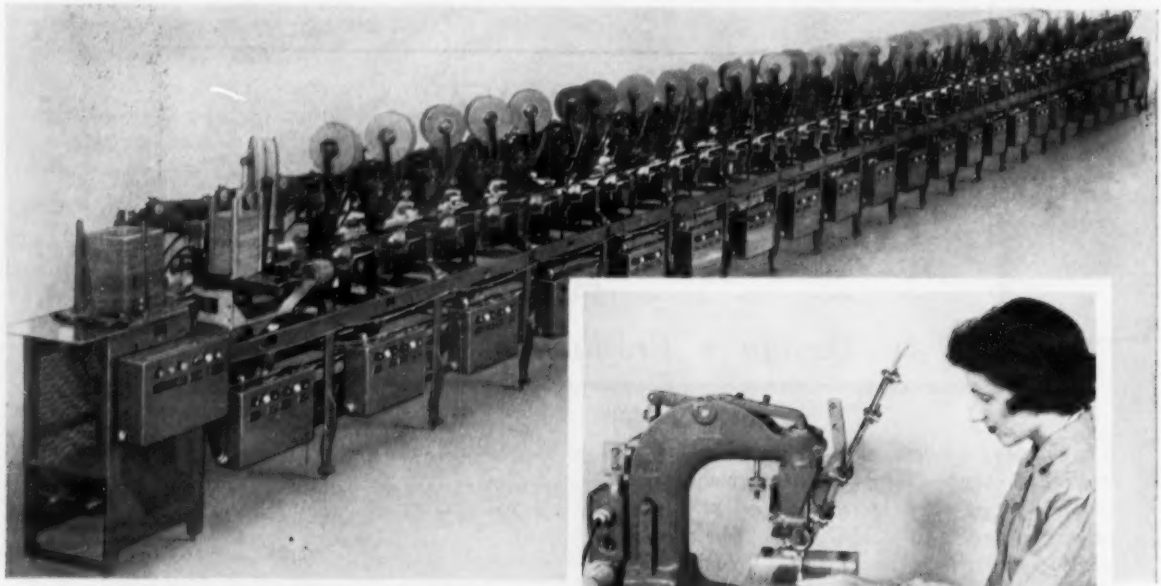
For complete details and information, write:

KAY ELECTRIC COMPANY

Dept. E-9

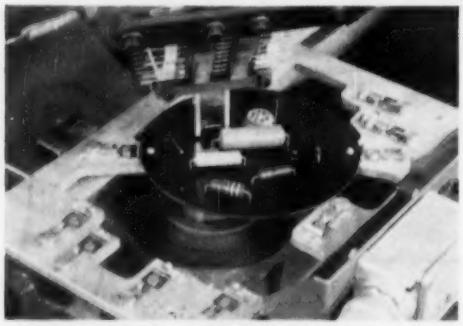
14 Maple Avenue, Pine Brook, N. J.

Want more information? Use post card on last page.

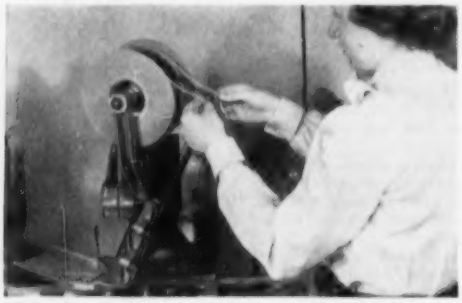


Above — Completely automatic 44 station, 75 foot long DYNASERT with printed wiring board loader. A similar United unit has been placed in operation by a large producer of TV receivers. Right — Individual inserting machines are the efficient way to insert components where volume of production does not justify the fully automatic equipment.

New United Component Inserting Machines Now in Commercial Operation



Accuracy of board location and minimum changeover time are primary advantages of United's pallet system. Multiple sets of dowel pins can be provided so that a single pallet handles a wide range of printed wiring board sizes and shapes.



Full reels of components which may be lead-taped as shown or body-taped are quickly slipped in place and spliced while United's conveyor assembler is running. Each reel holds about ½ day's supply.

"Dynasert" System Most Flexible for Automatic Insertion of Electronic Components

NEW, VERSATILE DYNASERT CONVEYOR, *operated automatically*, produces 9600 assemblies of electronic components per day. It is completely flexible. It will insert different components in any sequence and can handle a wide variety of printed circuits. Each station can be easily and quickly adjusted or can be readily relocated on the conveyor. Any number of stations may be added.

THE SINGLE STATION UNIT, *operated semi-automatically*, is a valuable assembly tool, increasing production, accuracy and uniformity over hand assembly while reducing operator fatigue. These advantages of DYNASERT bring new efficiencies to both small and large assembly operations. Get full details on DYNASERT — write Industrial Sales Division, United Shoe Machinery Corporation, Boston, Mass.

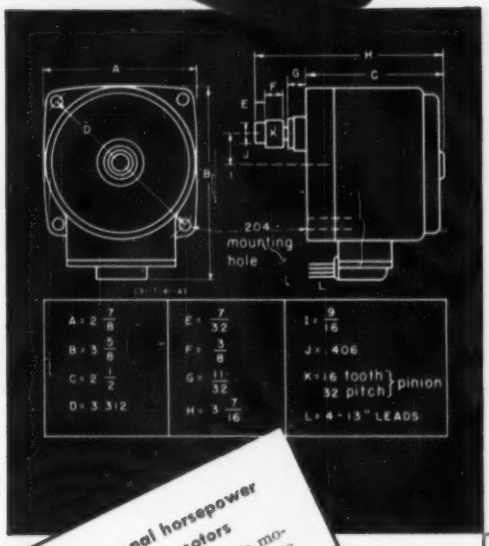
Brown 2-phase reversible motors give positive positioning, high torque

. . . in servomechanisms, computers, null circuits

THIS line of low inertia 2-phase motors provides high torque at low speeds. Ideal for numerous remote positioning applications, their performance has been proved by years of use as balancing motors in Brown *ElectroniK* instruments. They are self lubricating, and are totally enclosed . . . including the reduction gear train. They operate at ambients from 20 to 175 F.

A wide range of shaft speeds is available, including a new model with no-load speed of 1620 rpm. Rotor speed for all models is 1620 rpm. Power input is 115 volts, 60 cycles. 25 cycle models are also available. Line field takes 11 watts, amplifier field 2.5 watts. Motor load impedance averages 12,000 ohms. Dimensions are shown in the diagram.

For special applications, many variations in pinion, shaft, leads and materials can be supplied. Prompt delivery available on either standard or special models.



Order Now!

Prices from **$40.50**

(even more favorable depending on quantity)

					New ▼
No-load speed—rpm	27	54	162	333	1620
Rated torque—in. oz.	30	15	5	4	5
Max torque—in. oz.	85	43	19	11	9
rpm for max power	15	31	92	190	900

Brown fractional horsepower synchronous motors

Used for years as chart drive motors in *ElectroniK* recorders, these single-phase synchronous motors are ideal for many low-power continuous operations. External and mounting dimensions are the same as for the 2-phase balancing motors. Three different shaft speeds are available:

Nominal speed, rpm	30	60	180
Torque, in. oz.	20	10	4

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4428 Wayne Avenue, Philadelphia 44, Pa.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

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for America's Original Equipment Manufacturers

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all shapes . . all sizes . . all grades . .

CAST ALNICO . . SINTERED ALNICO . . HYFLUX ALNICO V HE . . INDOX CERAMIC MAGNETS . . CUNIFE . . AND OTHER SPECIAL MAGNET MATERIALS

FREE TECHNICAL HELPS:

If you are interested in obtaining magnets for your experimental work, write for Catalogs 11-A-9 or 12-A-9 which list a wide range of stock magnets available for immediate shipment. Catalog 11-A-9 covers *cast* permanent magnets . . . Catalog 12-A-9 covers *sintered* permanent magnets.

Also available without charge is a subscription to the publication, "Applied Magnetics." You should receive this publication if you're interested in or responsible for the design or development of products using permanent magnets.

Please send requests on your company letterhead

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COMPLETE LINE OF

by the World's

Largest Manufacturer of Permanent Magnets

Wide Range: From Valparaiso, Indiana, comes the widest range of permanent magnets in the world . . from tiny "U" shaped 1/10 oz. sintered Alnico permanent magnets to massive cast magnets weighing 1,000 pounds, and more! Many standard sizes and shapes are available from stock . . and quickly . . in 24 hours!

Largest Engineering Staff: For your special permanent magnet applications, Indiana offers the World's largest engineering staff devoted solely to the design and application of permanent magnets. This staff, backed by the World's largest and most complete magnetic research and production facilities, is available to consult with your own design engineering staff. Because Indiana makes *all* kinds of permanent magnets, you can be sure that only the magnet best suited to your product's requirements will be recommended.

Magnetic Specialists: Indiana Steel Products Co. has concentrated on manufacturing magnetic materials for almost half a century. All facilities, attention, and effort are channeled to magnetic materials . . and *only* to magnetic materials.

Trained Sales Engineers: Indiana Permanent Magnet salesmen are trained engineers. Frequently they are in a position to give your technical men on-the-spot suggestions. More often than not, they have already encountered problems similar to yours.

THE INDIANA STEEL PRODUCTS COMPANY

VALPARAISO, INDIANA

World's Largest Manufacturer of Permanent Magnets

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INDIANA PERMANENT MAGNETS

B-H Vinyl-Sil 8000 Fiberglas Sleeving

A "BAKER'S DOZEN" IN ELECTRICAL INSULATION

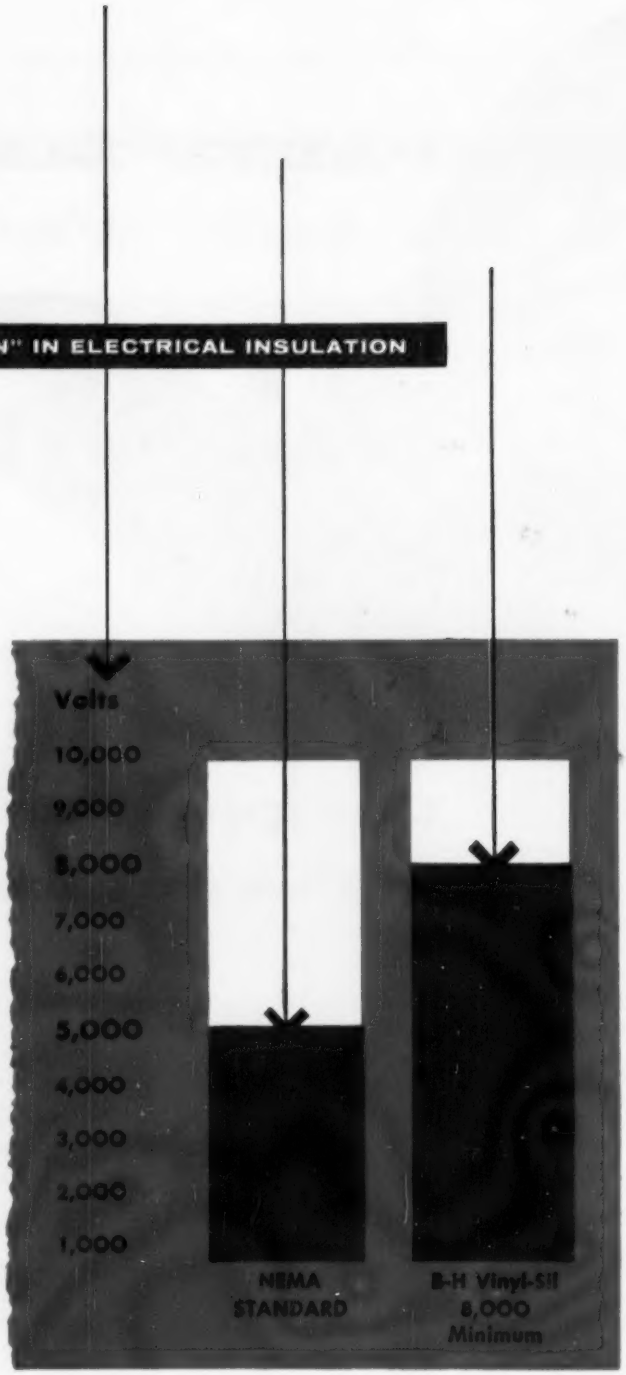
BH Vinyl-Sil 8000 *is* new, but behind it is 30 years' experience in the development and manufacture of high-dependability, electrical sleevings that set new standards of insulation performance. BH Vinyl-Sil 8000 Fiberglas Sleeving for instance, offers 8,000 volts *minimum* short-time dielectric breakdown . . . 3,000 volts beyond the NEMA and ASTM requirements for Grade B-A-1.

That's one big advantage of designing with this new sleeving that combines stabilized organic resins with those of the silicone group. Here are others . . . high resistance to heat-aging, flow, oils and chemicals, abrasion and cut-thru . . . −50°F. low temperature flexibility and *no* capillary attraction to water.

BH quality is no accident. Laboratory and field checks are used as a constant control measure. There's a continuing search for new and better materials aimed toward product improvement without increase in cost. The result — maximum protection for your products.

Data sheets and samples of BH Vinyl-Sil 8000 — and others in the dependable BH family of tubings and sleevings for electrical insulation — are yours for the asking. Tell us your insulation problem and we'll send test samples to answer your need —insulation-wise and cost-wise.

BENTLEY, HARRIS MANUFACTURING CO.
1309 Barclay Street
CONSHOHOCKEN, PENNSYLVANIA
Telephone: Conshohocken 6-0634



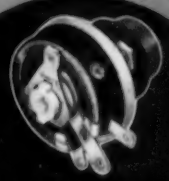
BENTLEY, HARRIS *Fiberglas** **SLEEVINGS**

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U.S. Pat. Nos. 2395550, 2647296 and 2647288). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

WORLD'S LARGEST STOCK

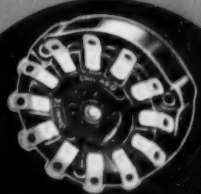
RESISTORS

Fixed and "Dividohm" adjustable wire-wound types, 10 to 200 watts. Also composition type.



RHEOSTATS

Ten stock sizes—25 to 1000 watts. All ceramic and metal.



TAP SWITCHES

Rotary type. Five sizes from 10 to 100 amp, with from 2 to 12 taps.

What resistance components do you need in a hurry? From a factory stock of several million resistors, rheostats, and tap switches . . . in 1,859 types, sizes, and values . . . Ohmite can make fast delivery in reasonable quantities to meet your immediate requirements.

Furthermore, by tailoring your specifications to these stock items, you can always get speedy delivery that will help you keep experimental and pilot production operations on a smooth-running schedule.

To assist engineers and purchasing agents in making their selection from this huge stock, Ohmite *Stock Catalog* No. 24 contains complete, up-to-date information on all Ohmite stock items. Resistance values, ratings, specifications, and other helpful information are included.

NEED RELAYS? Ohmite Amrecon Relays are available in 61 stock types. Write for Bulletin R-26.

SEND FOR STOCK CATALOG NO. 24

OHMITE®

MANUFACTURING CO.

30th Anniversary 1925-1955

3610 Howard St., Skokie, Ill. (Suburb of Chicago)

FOR HIGH CURRENT

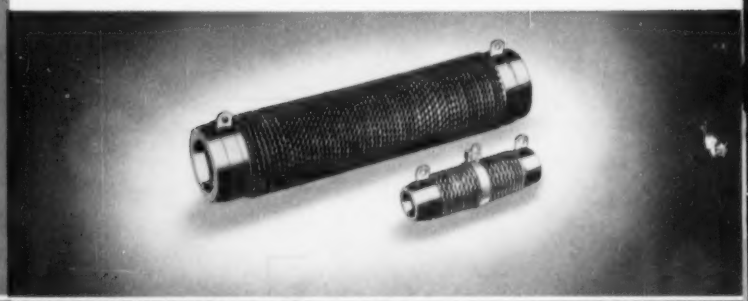
LOW RESISTANCE APPLICATIONS . . .

OHMITE® *Power Type* RESISTORS

CORRIB®

Vitreous-Enameled, Corrugated-Ribbon Type

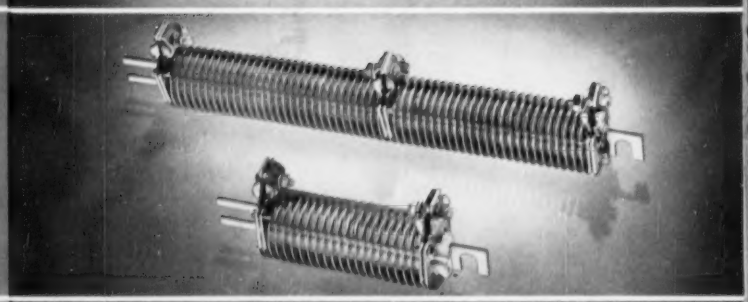
Special Ohmite vitreous enamel locks the edge-wound ribbon alloy to a sturdy ceramic core. Fixed, tapped, and adjustable types. Available in 22 sizes from 90 to 1500 watts. Resistance values range from .04 to 70 ohms.



POWR-RIB®

Edgewound-Ribbon Type

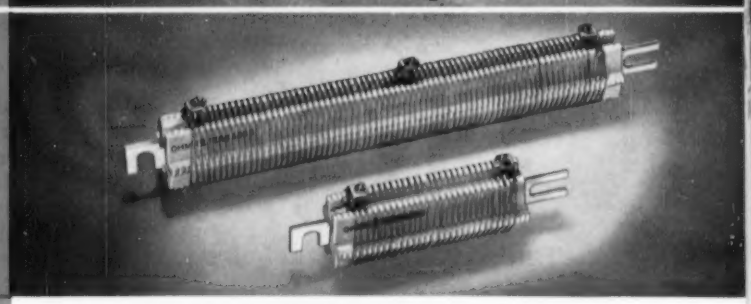
Has a heavy ribbon of resistance alloy, edgewound on a ceramic core. Core is sectionalized for flexibility and shock resistance. Terminals and brackets are plated to prevent oxidation. Four sizes in resistances from .043 to 1.6 ohms; and from 24 to 95 amperes.



POWR-RIB®

Round-Wire Type

Similar in construction to Ribbon-Wire type shown above, but with round resistance wire. Sturdy ceramic core is made in two to five sections. Available in four sizes. Resistance values from .69 to 25 ohms. Current ratings from 5.1 to 18.4 amperes.



Write for Bulletin 144

Available in fixed or adjustable "DIVIDOHM®" Types.

Be Right with OHMITE®

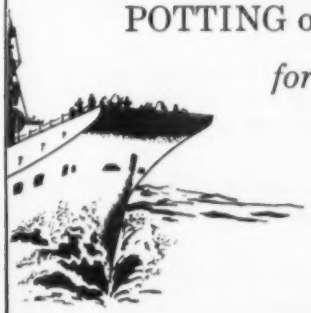
RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES

30th Anniversary 1925-1955

OHMITE MANUFACTURING COMPANY, 3610 Howard St. • SKOKIE, ILLINOIS (Suburb of Chicago)

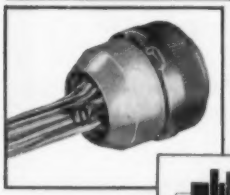
NEWEST METHOD OF SEALING AGAINST MOISTURE

POTTING of Cannon Connectors

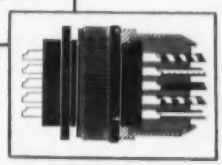


for... 1. ***Positive sealing*** against moisture, dirt, and other foreign matter.

2. ***Weight saving*** because of elimination of end bell and cable clamp.
3. ***Space saving*** due to shorter overall length.
4. ***Prevention of wire fatigue*** under extreme vibration.
5. ***Improved dielectric characteristics.***



Typical completed potted connector



Individual wires and elements are thoroughly sealed

CANNON offers these Connectors for Potting

CAO6BS Plug • Plastic Inserts 12S to 48 Sizes
CAO6BR Plug • Plastic Inserts 12S to 48 Sizes
CAO6ES Plug • Resilient Inserts 8S to 36 Sizes
CAO6ER Plug • Resilient Inserts 8S to 36 Sizes
CA3106BS Plug • Plastic Inserts 12S to 48 Sizes*
CA3106BR Plug • Plastic Inserts 12S to 48 Sizes*
CA3106ES Plug • Resilient Inserts 8S to 36 Sizes*
CA3106ER Plug • Resilient Inserts 8S to 36 Sizes*

*less grounding means

Receptacles also available for potting.

Plugs and receptacles available with either pin or socket assemblies.

Please Note: Many other connectors may be potted by devising proper potting techniques.

CANNON Potting Molds

Nylon potting cup

Aluminum end bell

How It's Done...

Potting is a newly developed method of obtaining complete protection, covering, and sealing around the solder cups and wires at the rear of electric connectors by means of a sealing compound applied at the time the connectors are wired into their assemblies. The terminal area enclosed by the plug or receptacle end bell is filled or potted with a free flowing high solids synthetic rubber compound. This cures at room temperature to form a firm, resilient, moisture and vibration resistant rubber seal.

Clean the Connector...

The connector should be free of grease, oil and wax in order to insure good adhesion. Do not expose insulating materials to the cleaning solvent beyond the time necessary for adequate cleaning. *See the new Cannon Manual on Potting for complete information.*

Mixing the Compound...

Compounds are usually furnished as a basic sealant compound and an accelerator. Mixing must be done carefully, either by hand or with power equipment. *This subject is covered fully in new Cannon Manual on Potting.*

Applying the Sealant...

Application of the sealant can be made with a small paddle-shaped tool, spatula, putty knife or a flow gun. However, the flow gun is the preferred method where larger quantities of the plugs are to be sealed. *Methods are discussed fully in the new Cannon Manual on Potting.*

Potting Machines...

Large quantity runs can be handled economically by potting machines. Typical equipment of this nature is illustrated here.

Potting machine in use

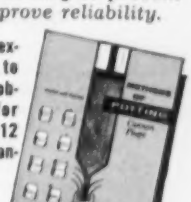
Potting by hand

Curing Time...

Curing time and the methods used are very important. The length of time that it takes for the sealant to harden and cure varies with the material used. Generally, the length of cure time depends upon the work life of the compound. A longer work life increases and short work life decreases the cure period. *See the new Cannon Potting Manual for complete details.*

MIL-S-8516 (Aer) is basic specification on sealing compounds for electric connectors and electric systems. BuAer Bulletin Aer-EL-35 covers electric connector sealing to prevent contamination, improve reliability.

Cannon's engineering experience is available to you on your potting problems. Write TODAY for assistance and for new 12 page, 2-color, Potting Manual No. PM-1.



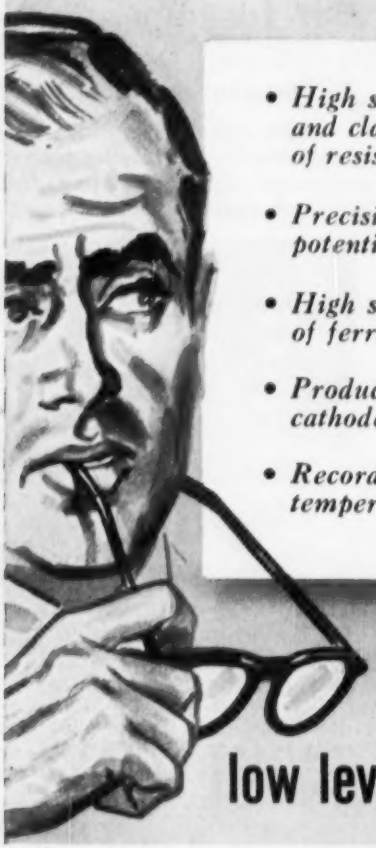
40th YEAR

Please mention this magazine or Dept. 120

CANNON PLUGS

CANNON ELECTRIC CO., 3209 Humboldt St., Los Angeles 31, California. Factories in Los Angeles; East Haven; Toronto, Canada; London, England; Melbourne, Australia. Manufacturing licensees in Paris, France; Tokyo, Japan. Representatives in all principal cities.

These or similar problems puzzling you?



- *High speed inspection and classification of resistive elements*
- *Precision control of minute potentials and currents*
- *High speed inspection of ferromagnetic materials*
- *Production testing of cathode ray tube brightness*
- *Recording extremely low temperature differentials.*
- *Continuously recording rate of temperature change in jet engine test stands*
- *R.M.S. regulation of a-c oscillators and generators*
- *Multiplication of two a-c or d-c signals to provide a precision product*
- *Precision low power factor measurements for production inspection of transformers and motors*

The INDUCTRONIC® SYSTEM of low level MEASUREMENT and CONTROL

Model 1475 Multi-Range Inductronic D-C Amplifier provides amplification of a complete span of direct current and voltage ranges of either polarity with no sacrifice in fundamental accuracy or speed. Has seven current ranges, from 10 to 1,000 microamperes — and ten voltage ranges, from 1 to 1,000 millivolts. All ranges immediately available by the turning of a switch; and an additional seventeen ranges become available by a knob adjustment which changes the instrument from zero left to zero center. Accuracy 1%. Accessories such as recorders and additional indicators can be inserted in the output to a total of 5,000 ohms without affecting accuracy or calibration.

Practical solutions to the above, and many other problems of low-level measurement and control have been supplied by the WESTON Inductronic System . . . an entirely *different* method of d-c amplification. Utilizing the deflection of a permanent magnet moving coil system, it converts extremely low-level d-c to a proportionate a-c signal and amplifies it to a *usable degree* . . . then reconverts to a d-c level. The system operates at a frequency of 200 KC, and provides a high order of sensitivity, accuracy and speed. And because of circuit simplicity, the system is stable and virtually maintenance free. To learn how you can apply the Inductronic System in research or production, call your nearest Weston representative, or write direct for bulletin B-36-B.

WESTON *Instruments*

WESTON ELECTRICAL INSTRUMENT CORPORATION, 614 Frelinghuysen Avenue, Newark 5, New Jersey

DEVELOPED FOR APPLICATIONS ...

... beyond today's horizons

New HEIGHTS OF PERFORMANCE Achieved by advance-design **ASTRON CAPACITORS AND R.F. FILTERS**

Today's design requirements foreshadow tomorrow's revolutionary applications . . . imposing critical new areas of performance on electronic components.

The vexing problem of efficient capacitor and R. F. filter operation under these ultra-severe conditions of extreme heat, cold, moisture and vibration challenges the imagination of the component manufacturer . . . truly he must create "something completely new under the sun"!

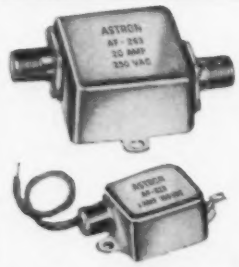
A foremost pioneer in the exacting development of advance-design components, to cope with these requirements, is Astron . . . leader in miniaturization, manufacturer of industry's widest variety of types, whose experience, ability and creative far-reaching point of view produces the significant, highly-engineered designs pictured here . . . proof of a dedication to progress.

The types and styles illustrated are but a few of the many available . . . for complete technical and application information on all Astron products, please request catalog AC-4.

Blue • Point® Molded Plastic Paper Capacitors

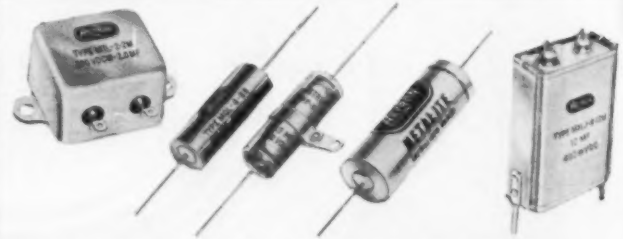
Meteor® High Temperature Miniaturized Capacitors

Series "X"* Mylar † - Plus Capacitors



R. F. Noise Suppression Filters. Complete noise suppression "Packaged" service—Definition of requirements • Engineering analysis • Efficient solutions • Advance-type components • Quality production.

Comet* Molded Plastic Metallized Paper Capacitors

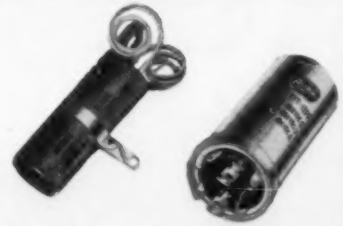


Metalite® and Hy-Met* Sub-Miniature Metallized Paper Capacitors

Attention: West Coast Buyers

Astron now maintains a complete West Coast Stock of all standard items . . . see your local Astron distributor.

Safety Margin "SM"* Miniature Electrolytic Capacitors



Safety Margin "SM"* Twist-Prong and Cardboard Cased Electrolytic Capacitors

MIL-Type Hermetically Sealed Paper Capacitors

ASTRON CORPORATION
255 GRANT AVENUE EAST NEWARK, N. J.

Export Division: Rocke International Corp., 13 E. 40th St., N. Y. C. In Canada: Charles W. Pointon, 6 Alcina Ave., Toronto 10

versatile

Multi-channel -- telegraph A1 or telephone A3.

FROM GROUND TO AIR OR POINT TO POINT

STABLE

High stability (.003%) under normal operating conditions.

RUGGED

Components conservatively rated. Completely tropicalized.

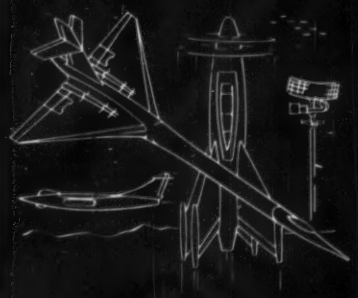
Model 446 transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-24.0 Mcs (1.6-2.5 Mcs available). Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts, A1 or A3. Stability .003%. Operates in ambient –35° to 45°C. Nominal 220 volt, 50/60 cycle supply. Conservatively rated, sturdily constructed. Complete technical data on request.

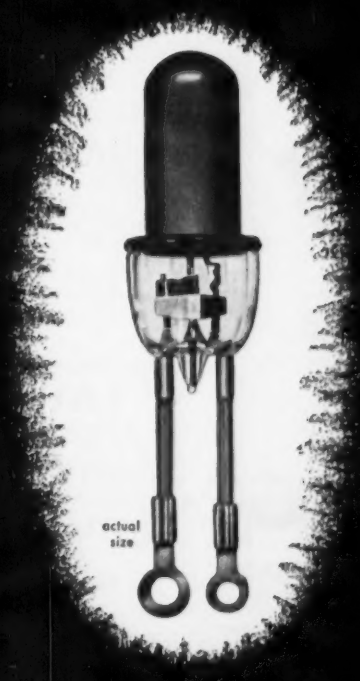
Here's the ideal general-purpose high-frequency transmitter! Model 446... 4-channel, 6-frequency, medium power, high stability. Suitable for point-to-point or ground-to-air communication. Can be remotely located from operating position. Co-axial fitting to accept frequency shift signals.

AER -O- COM

3090 DOUGLAS ROAD MIAMI 33, FLA.

DESIGN IS OUR BUSINESS





ANNOUNCING UNITED TYPE 589

CLIPPER-DIODE RECTIFIER

Ever so small, and light for its power capabilities, our new type 589 electron tube will help immeasurably in concluding many electronic design problems, especially for aircraft and missile environment.

This new external anode tube weighs only a little over ¾ of an ounce, is less than 2 inches long, yet is rated as a clipper diode for 10,000 volts epx, and for peak plate current of 8 amperes.

For oil emersed rectifier operation rated epx is 16,000 volts and average plate current rating is 65 mAdc.

For convection cooled rectifier operation rated epx is 16,000 volts and average plate current rating is 30 mAdc.

Shock rating is 300 g.

MECHANICAL DATA

Nominal Overall Dimensions:	
Length (Less lead)	1.9 inches
Lead Length	1.5 inches
Diameter	.9 inches
Anode Dimensions:	
Length (for contact)	.8 inches
Diameter	.6 inches
Bulb	Per illustrations
Mounting and Anode Contact	Per illustrations
Filament Terminals	Per illustrations
Type of Cooling	Liquid
Net Weight	0.8 oz.
Shock Rating	300 g.
Vibration Rating at 500 cps	10 g.

ELECTRICAL DATA

General:	
Heater Voltage	6.3 Vac.
Heater Current	1.6 Aac.
Cathode	Coated Unipotential
Maximum Rectifier Ratings (Liquid Cooled):	
Peak Inverse Voltage	16.0 kv.
Peak Plate Current	250 ma.
Average Plate Current	65 mAdc.
Maximum Coolant Temperature Range	−65° C to +165° C
Maximum Rectifier Ratings (Radiation Cooled):	
Peak Inverse Voltage	16.0 kv.
Peak Plate Current	120 ma.
Average Plate Current	30 ma.
Maximum Clipper Diode Ratings (Liquid Cooled):	
Peak Inverse Voltage	10.0 kv.
Peak Current	8 a.
Average Plate Current	20 ma.

UNITED ELECTRONICS, 42 Spring Street, Newark 2, N. J.

TAILOR-MADE

. . . at "store-bought" prices!

OVER NINETY PERCENT of the GLOBAR® Resistors available today have been engineered in the correct sizes, shapes, resistance values—*and characteristics*—to solve *specific* circuit problems completely and economically . . . including *yours!*

Why shop around for "stock" items when GLOBAR® Resistors cost no more? Let us convince you.

Always Specify

GLOBAR®

Ceramic Resistors

GLOBAR DIVISION • The Carborundum Company • Niagara Falls, New York

A NEW LINE OF BROADBAND MICROWAVE COMPONENTS

MICROWAVE TEST ANTENNAS

Covering 1,000 to 26,600 mc. Rugged, portable units built especially for field intensity measurements, antenna pattern recording, leakage measurements and other communications use. Supplied complete with tripod mount, adjustable pan head, and convenient carrying case.

Each of these Polarad test antennas is highly directional with excellent front to back ratio, and is supplied with flexible waveguide or coax couplings.

MODEL No.	FREQUENCY RANGE	MAX. VSWR
A-L	1,000 to 2,300 mc	3:1
A-S	2,150 to 4,600 mc	2:5
A-R	4,450 to 8,000 mc	2:5
A-X	7,850 to 12,400 mc	2:7
A-KU	12,400 to 18,000 mc	1.5:1
A-K	18,000 to 26,000 mc	1.5:1

BROADBAND-PASS FILTERS

Covering 650 to 13,000 mc. These Polarad Broadband-Pass filters are the first of their kind commercially available. They feature sharp skirt selectivity and low pass band insertion using standard 50 ohm co-axial connections. Curves showing typical bandpass characteristics are available on request.

MODEL No.	FREQUENCY RANGE
F 650	650 – 1,300 mc
F 1100	1,100 – 2,200 mc
F 1800	1,800 – 3,600 mc
F 3500	3,500 – 7,400 mc
F 6100	6,100 – 13,000 mc

MICROWAVE WAVEMETERS

Covering 500 to 4000 mc. Precision, adjustable, cavity-type meters designed for measuring frequency with ± 0.2% accuracy over the range 500 to 4000 mc. Each meter in the series has a 2:1 frequency range. Specific frequency metering is accomplished by adjustment of micrometer head until a dip of at least 20% in output occurs when input or output impedance is nominal 50 ohms. Micrometer head readings are easily converted to frequency by using calibration chart furnished with each instrument. Utilizes Type "N" coax connectors.

MODEL	FREQUENCY RANGE
FR	500 – 1,000 mc
FL	1,000 – 2,000 mc
FS	2,000 – 4,000 mc

MICROWAVE ATTENUATOR—Model SIJ

Covering 4,000 to 12,400 mc. A continuously variable, stub-tuned, mutual inductance attenuator (waveguide beyond cut-off) designed for external use in making microwave measurements with spectrum analyzers, signal sources, receivers and for power measurements. The Model SIJ can be used as a standard calibrated attenuator; for circuit protection; or for monitoring and measuring. It will insure RF circuit isolation. It may be used to convert signal source or laboratory oscillator into a signal generator.

SPECIFICATIONS:

Frequency Range:	4 to 12.4 kmc
Impedance:	50 ohms
Attenuation Range:	130 db
Minimum Insertion Loss:	Approximately 10 db depending on frequency.

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ELECTRONICS CORPORATION

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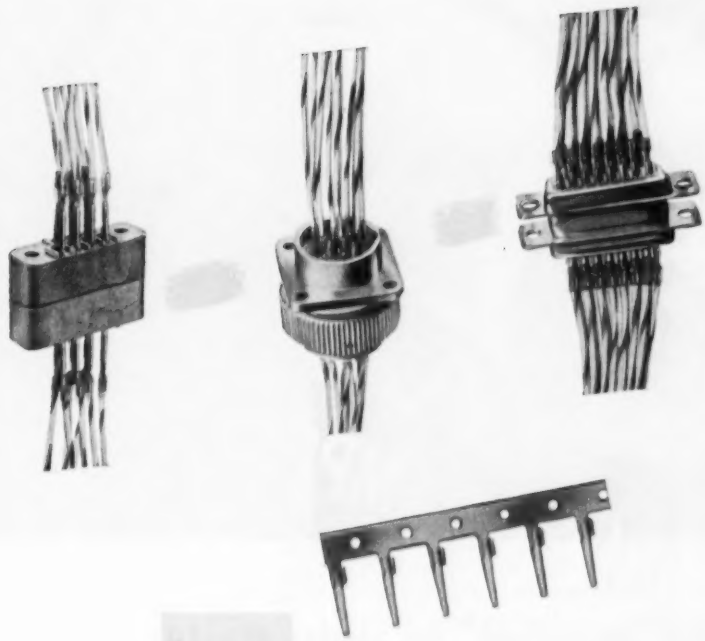
Announcing A-MP®

MINIATURE *TAPER PINS*

FOR MINIATURIZED COMPONENTS!

Send today for your copy of "A-MP's Creative Approach to Better Wiring"

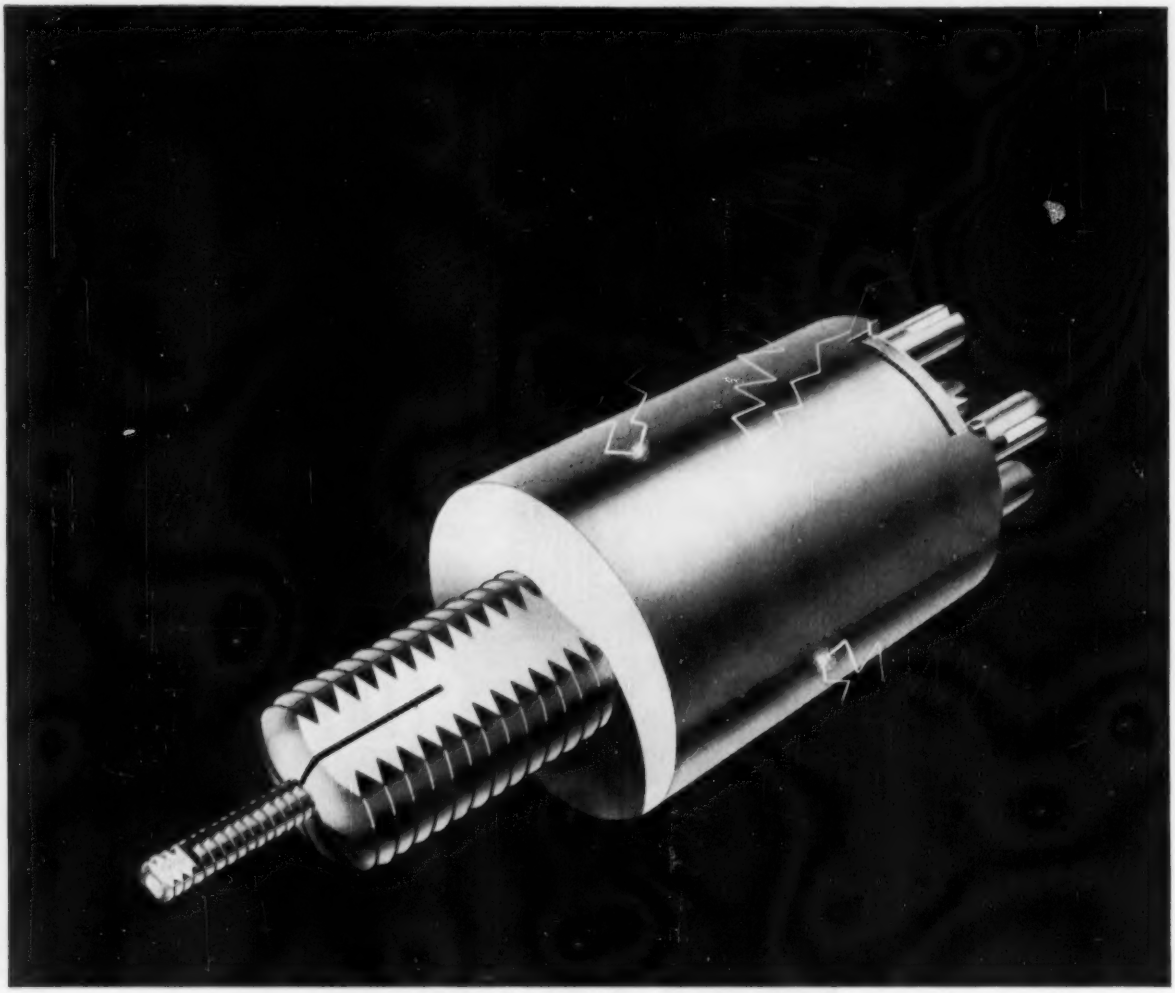


A-MP's new Miniature Taper Pins, shown here actual size, provide the same uniformly reliable wire connections for your miniature components, as the larger, widely used and accepted A-MP Taper Pins. Miniature Taper Pins are applied to wire with A-MP Automatic Machines at speeds up to 4000 per hour. They are then inserted into components quickly and easily with A-MP CERTI-LOK Insertion Tools. Miniature Taper Pins are available for wire sizes #26 to #20.

A-MP®

©A-MP

AIRCRAFT-MARINE PRODUCTS, INC., 2100 Paxton Street, Harrisburg, Pa.
In Canada: AIRCRAFT-MARINE PRODUCTS OF CANADA, LTD., 1764 Avenue Road, Toronto 12, Ontario, Canada



Built for close "combat" in tight spots

Into the construction of this coil form goes C.T.C.'s rigid *quality control* to highest production standards.

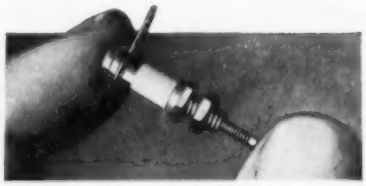
The result is another C.T.C. *first* — a miniaturized coil form (1/16" diameter by 1/2" high when mounted) that is shock-resistant and exceptionally rugged — shielded against radiation, electrically, and therefore ideal for "close quarter" use in I.F. strips and numerous designs where adjacent mounting is necessary.

C.T.C.'s policy of continuous step-by-step quality control in the manufacture of every component means guaranteed performance. Already certified materials are doubly checked before manufacture.

Whatever your component need — let C.T.C. solve your problem — with either custom or standard designs of *quality-controlled, guaranteed* components — including insulated terminals, coil forms, coils, swagers, terminal boards, diode clips, capacitors and a wide variety of hardware items.

Put *your* component problem up to C.T.C. now. For samples, specifications and prices — write today to Sales Engineering Dept., Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge, Mass. On West Coast, contact E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 or 988 Market St., San Francisco, California.

Coil Form Data: C.T.C.'s LS-9 coil form has a brass shell enclosing a powdered-iron cup-core, tuning slug, phenolic coil form and silicone fibreglas terminal board. Three terminal boards are available with choice of two, three or four terminal layout. Forms, unassembled, may be had *without windings . . . or wound and assembled to your specifications.*



Capacitor: New CST-50 variable ceramic capacitor surpasses range of capacitors many times its size. Stands only 1 9/32" high when mounted, is less than 1/4" in diameter and has an 8-32 thread mounting stud. A tunable element of unusual design practically eliminates losses due to air dielectric giving large minimum to maximum capacity range (1.5 to 12MMFD).

CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components, custom or standard

DU PONT

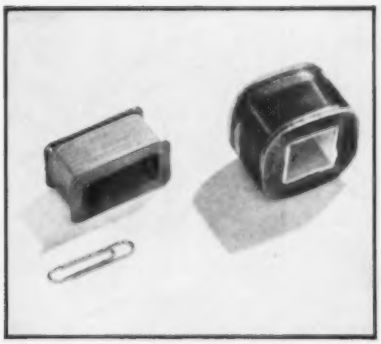
Better Things for Better Living . . . through Chemistry

ELECTRONIC DESIGN NEWS

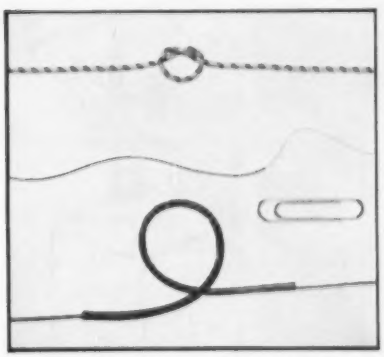
PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 4 — 1955

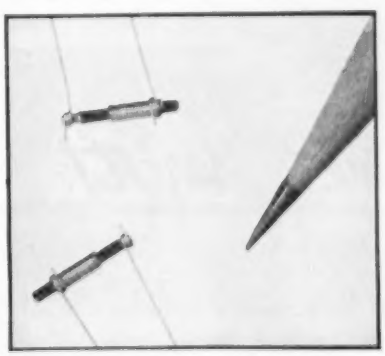
Miniaturized Components Utilize Unique Insulating Properties of TEFLON®



The paper clip indicates the small size of these coils. The insulation of "Teflon" is one important reason why they can be miniaturized.



Here are shown (top) a striped, wrapped lead wire and (bottom) two samples of miniaturized flexible sleevings—all insulated with "Teflon."



These small capacitors use "Teflon" as the dielectric. Their degree of miniaturization is shown by comparison with end of lead pencil.

Working temperature range of Du Pont "Teflon": —450°F. to +500°F.

Miniaturization of electronic components is possible with a unique engineering material: Du Pont "Teflon" tetrafluoroethylene resin.

"Teflon" has a low loss factor, low dielectric constant, and high volume resistivity. It is nonflammable, and unaffected by moisture. "Teflon" is the only insulating material available today that is inert to every commercially used solvent and chemical, excepting only molten alkali metals and fluorine at high temperatures and pressures.

Use of "Teflon" helps cut production costs, too. In soldering operations, the iron will not burn or melt insulation of "Teflon." This important fact can save time, labor, and materials.

The three photographs on this page show some current uses for insulation of "Teflon." The wire is manufactured by Hitemp Wires, Inc., Mineola, New York. Other typical applications by Hitemp which utilize Du Pont "Teflon" are listed below.

The six products listed, insulated with "Teflon" and used in a wide variety of applications, illustrate the application of this material in current electronic designs:

MAGNET WIRE. Such wire, coated with "Teflon," is widely used on high-temperature components for aircraft and guided missiles: transformers, relays and various types of motors.

HOOKUP WIRE AND LEAD WIRE. Insulation of "Teflon" on hookup and lead wire proves advantageous on transformers, motors, and harness assemblies for high-temperature applications. The chemical resistance of "Teflon" is particularly valuable in gyros and other hermetically sealed components.

COAXIAL CABLE. Used as the dielectric medium of coaxial cable, "Teflon" permits the design of miniature constructions which are the equivalent of coaxial cables using much thicker insulation of other materials.

TUBING. Insulation of "Teflon" provides excellent protection for tubing used as bus wire and jumpers.

RESISTANCE WIRE. Insulation of "Teflon" on small resistance wire facilitates miniaturization of heating equipment.

FIBER-GLASS PRODUCTS. Insulation of "Teflon" is being applied currently to such fiber-glass products as lacing, tape and sewing thread. "Teflon" provides excellent temperature resistance, and withstands cutting action of glass fibers.

NEED MORE INFORMATION?

CLIP THE COUPON . . . If you would like further information about the properties and uses of "Teflon" as an electronic design material, fill out and mail the coupon.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department
Room 229, Du Pont Building, Wilmington 98, Delaware
In Canada: Du Pont Company of Canada Limited,
P. O. Box 660, Montreal, Quebec

Please send me more information on the Du Pont engineering materials checked: ☐ "Teflon"* tetrafluoroethylene resin; ☐ "Alathon"* polyethylene resin; ☐ "Zytel"* nylon resin; ☐ "Lucite"* acrylic resin. I am interested in evaluating these materials for_____

NAME_____

POSITION_____

COMPANY_____

STREET_____

CITY_____ STATE_____

TYPE OF BUSINESS_____

* *"Teflon," "Alathon," "Zytel" and "Lucite" are registered trademarks of E. I. du Pont de Nemours & Co. (Inc.)*

Phelps Dodge modern fits new

First for Lasting Quality—from Mine to Market!

enamel wire exacting coil designs!

New processes and controls assure uniform quality:

1. **Uniform over-all size—for uniform windings.**
2. **Uniform softness with high tensile strength for tighter windings, reduced breakage.**
3. **Uniform spooling, larger packages for lower-cost windings.**
4. **Uniform property balance for good flexibility, solvent resistance and dielectric strength.**

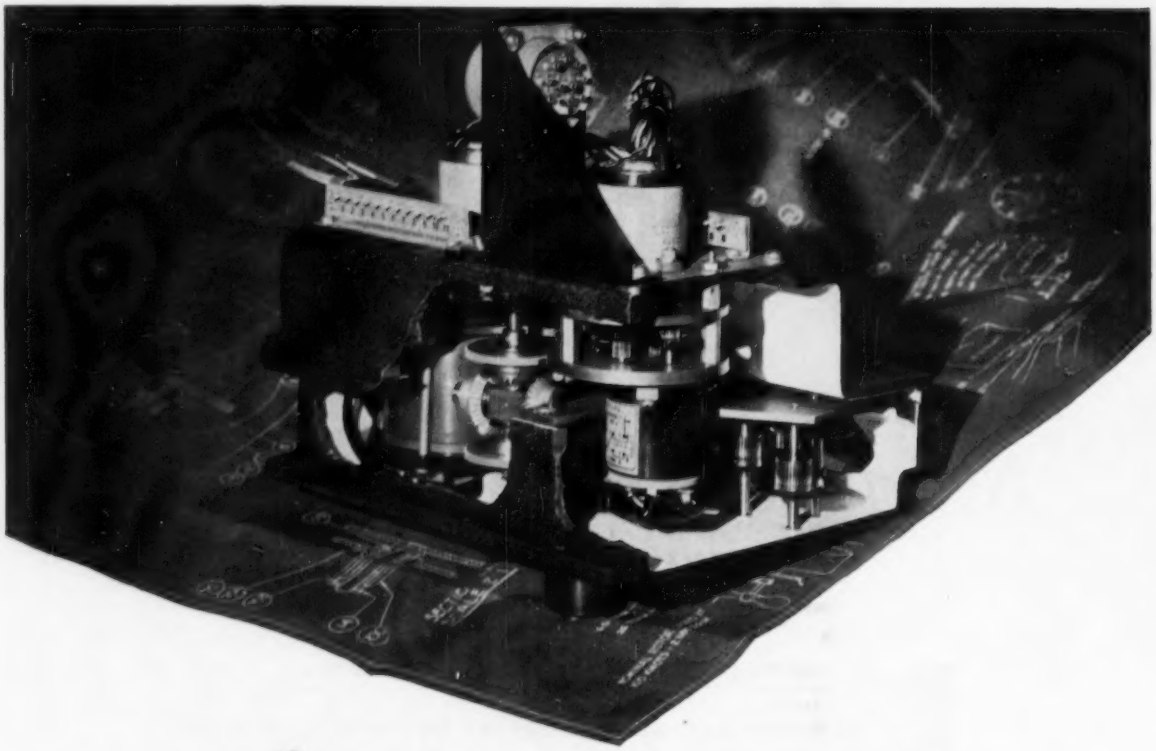
Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA

Want more information? Use post card on last page.



Creative Engineering

OF ELECTRO-MECHANICAL ASSEMBLIES . . .
FROM "PILOT STAGE" TO PRODUCTION EFFICIENCY

Here's how Atlas helps you develop new assemblies and components for radar and sonar systems, computers, and other electro mechanical devices.

You bring your designs to us. Atlas experienced production and methods engineers layout the job using new cost-cutting methods, improved processing techniques. Atlas toolmakers build dies and fixtures to implement these plans. Atlas skilled mechanics and assemblers produce prototypes to your exact specifications. Atlas metallurgical and electronic technicians test your product. Your next step is when your plant or Atlas takes over for volume production.

Atlas furnishes the practical engineering step between idea and production line. We've been "precision-eering" on a contract basis for many years. May we work with you? Write for booklet "Precision-eering Electro Mechanical Equipment." ATLAS Precision Products Co., Phila. 24, Pa. (*Division of Prudential Industries*).

"From Drawing Board . . . to Production Line"

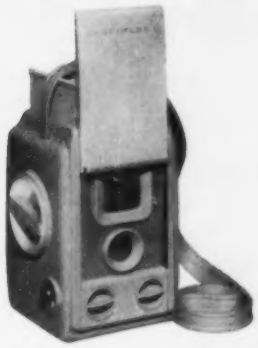
ENGINEERING • PRODUCTION • ASSEMBLY

SERVICE ATLAS DEPENDABILITY QUALITY

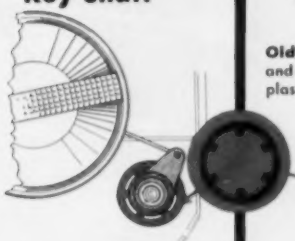
ATLAS
Precision Products

5 Waldes Truarc Rings simplify assembly, eliminate parts, bring big over-all savings to new design low-cost camera

Anscoflex II Camera



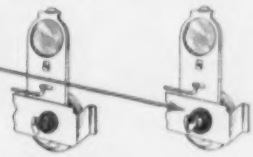
Key Shaft



Parts originally designed for self-locking Truarc ring (series 5105). Some cameras in the past had brass cup staked to the body. At times staking operation cracked the plastic, resulting in loss of expensive part.

Portrait and Filter Lens Knob Assemblies

Old way: Knob with plastic shaft used washer and heat forming operation that flattened the plastic pin and locked the pivot in position.

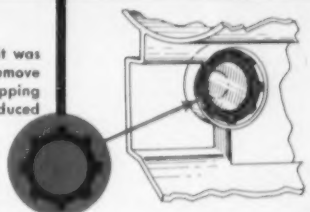


Truarc way: Molded plastic knob with pin is easily and quickly held by a Truarc self-locking ring (series 5105). No groove is necessary. Washer is eliminated and it is possible to remove ring if necessary without damage to knob.

Winding Knob

Old way: With screw and washer design, it was necessary to disassemble entire camera to remove screw which secured winding knob. Self-topping screw sometimes failed to secure knob, produced excessive end play.

Truarc way: Truarc "E" ring (series 5133) allows removal of winding knob without major disassembly of camera, reducing repair time. Use of stacked rings and Truarc applicator saved $10.40 per M on labor. Material saving: $2.29 per M.

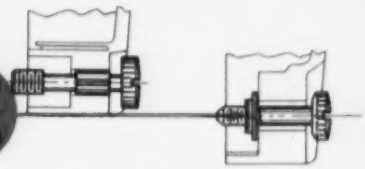


Rear Lens

Parts originally designed for self-locking Truarc ring (series 5005). Some cameras in the past had glass element secured by heat forming tabs from plastic body. Loose or chipped elements resulted in loss of both parts.

Flash-Gun Case Assembly

Old way: In the original design a sleeve was wrapped around neck of screw and pressed into hole of plastic cover. Close working areas made assembly difficult and required extra operation to lock ring into place.



Truarc way: Series 5133 E-Ring snaps onto unthreaded shank of screw quickly, needs no special groove. Labor saving $7.06/M.

Ansco, Binghamton, N. Y., uses the latest technical advances in construction to produce an economical, easy-to-use reflex camera. 5 Waldes Truarc Rings are used in this new design to save material and labor costs, eliminate parts, simplify assembly and reduce rejects.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!

Send for new catalog supplement

WALDES

TRUARC®

RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
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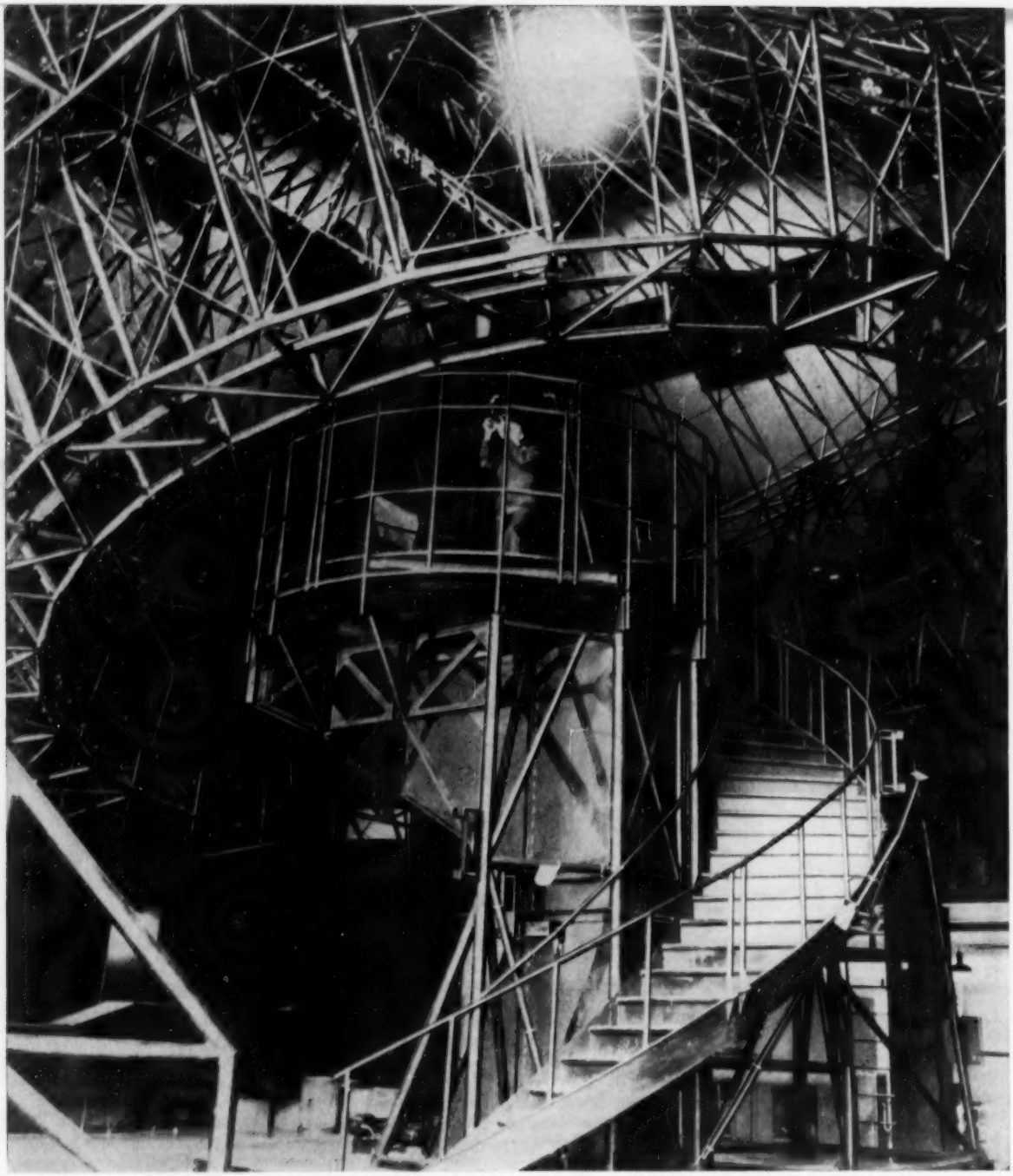
1097

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

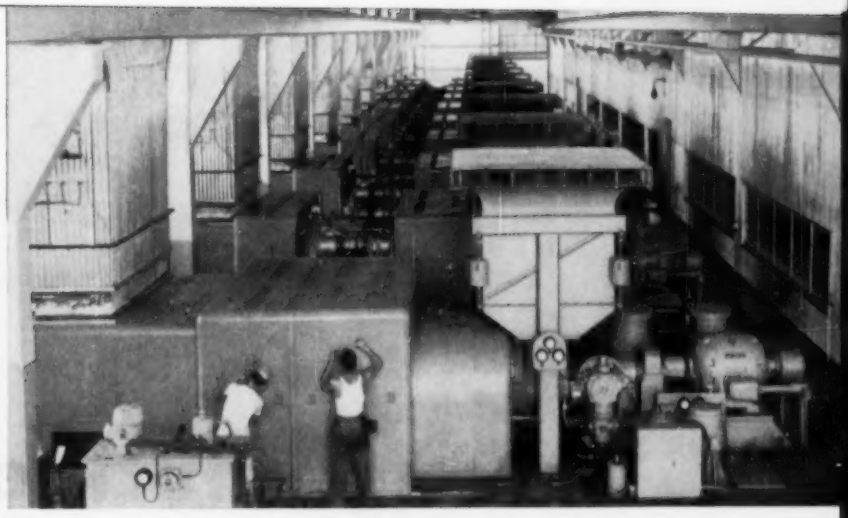


CELESTIAL NAVIGATION—Link Aviation's high-speed, high altitude celestial navigation trainer; only such trainer capable of simulating trans-Polar flight. Trains navigators in techniques of guiding planes by the stars.

Vital Controls

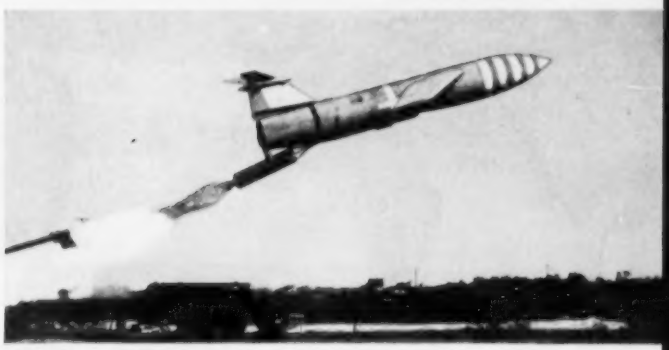
The controls on the world's fastest submarine; the most advanced airborne navigation system known to exist; other similarly advanced military systems and equally advanced industrial equipment and control systems are outstanding examples of the work of the producing companies of General Precision Equipment Corporation. More than a dozen major industries are served by instrumentation and systems designed, developed and produced by GPE Companies.

Ten of the companies in the GPE Group—notably Askania, Kearfott, Librascope and Link Aviation—devote substantial resources to the development and manufacture of instruments, servos and controls. These are used in equipment and systems developed by these companies



PROCESS CONTROL—Askania controls regulate speed of the ten turbines which develop compression to maintain gas suction pressure in Creole Petroleum Corporation's giant, pile-supported oil drilling operation on Lake Maracaibo, Venezuela.

SUBMARINE OPERATION—Controls developed and produced by Askania Regulator Company are utilized to govern operation of U. S. Navy's modern Guppy type submarines.



MISSILE GUIDANCE—One of the many guided missiles equipped with Kearfott basic gyro reference systems, the B-61 Matador—U. S. Air Force's first successful ground-to-ground tactical weapon.

GPE

CAPACITIES

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●● Manufacturing and product development
●●● Manufacturing, product development and research
○●● Pilot manufacturing, product development and research

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PRECISION MECHANICS, OPTICAL DEVICES, CERAMICS	●●●	●●	●●	□●●●	●●	●●●	●●	●●●	●●	●●	●●	●●●
ELECTRICAL EQUIPMENT and COMPONENTS	●●●	●	●			●●●	●●●	●●	●	●●	●	●●●
ELECTRONICS	●●●	●●	●●●	●●●		●●●	●	●●		●●●	●●	●●●
HYDRAULICS, LIQUIDS PROCESSING, HEAT EXCHANGE		●●			●●●					●●●		
TELEVISION Studio, Theatre, Educational, Business, Industrial		●		●●●		●				●		
INSTRUMENTS, SERVOS, CONTROLS Hydraulic, Pneumatic, Magnetic, Electronic	●●●	●	●●	□●●●		●●●	●●	●●		●●●	●	●●●
AIRCRAFT and MISSILE GUIDANCE, CONTROL, SIMULATION	●●●	●		●●●		●●●	●			●●	●	●●●
AUTOMATIC COMPUTERS and COMPONENTS	●●●	●	●	□●●		●●●				●●●		●●●
RADAR, MICROWAVE, ULTRASONICS	●●●	●	●●	●●●		●●		●		●		
MOTION PICTURE and AUDIO EQUIPMENT		●●●		□●●			●●	●●●	●●●		●●●	
NUCLEAR POWER COMPONENTS and CONTROLS	●●●				●●					●●		●●●
SYSTEMS ENGINEERING Aeronautical, Naval, Industrial	●●●			●●●	●●●	●●●				●●●		●●●

themselves, as well as in systems and equipment developed and produced by other manufacturers of advanced technological equipment.

All GPE Producing Companies work in the advanced areas of highly specialized fields and are engaged in the design, development, manufacture and sale of equipment which is closely related from a technical point of view. It is all precision equipment; it derives from similar fields of technical competence; it saves labor, increases productivity or achieves results which cannot be achieved with even limited use of on-the-spot manpower. The chart here shows the specialized fields in which the key GPE Producing Companies work.

In addition to specialization in its particular products and fields of technical competence, each of these companies has at its command, as required, the facilities and specialized techniques of the other GPE Companies in their respective fields. Interrelation of their resources is achieved through GPE's basic operating policy, GPE Coordinated Precision Technology. In all areas in which GPE Companies work, this coordination has been responsible for a wide variety of precision equipment of superior design and performance, embodying new, advanced principles.

A brochure relative to the work of the GPE Companies and GPE Coordinated Precision Technology is available. Address your request, or specific inquiries, to: GENERAL PRECISION EQUIPMENT CORPORATION — 92 Gold Street, New York 38, N. Y.

This fastener works through thick and thin!

Spring-Lock—the easy-to-use removable fastener for modern designs—works whether panel thicknesses run over or under specifications! Spring wire deflects automatically to handle greater or lesser thicknesses. Spring-Lock's design flexibility makes it more than a fastener: it can be adapted as a shelf support, door strike, knob or any similar panel-mounted device. Many standard shapes and sizes of Simmons Spring-Locks are available from stock.

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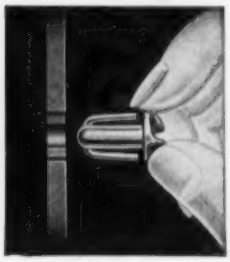


1. *Insert fastener.*

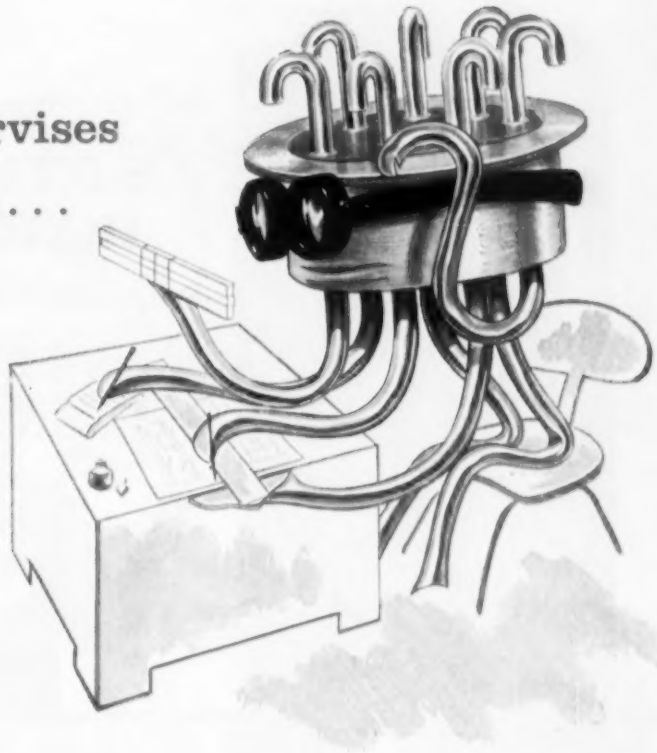
2. *Half-turn locks it in place.*

With production costs on the uptrend, you can figure on Spring-Lock as an assembly time and money-saver, because:

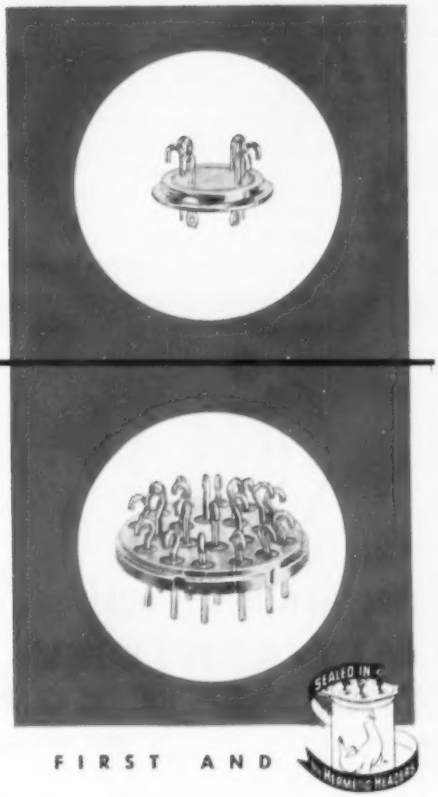
- **Installation is BLIND**
- **Installation is EASY: no special tools are needed**
- **Installation is QUICK: a half-turn locks it in place**
- **Installation is SECURE: the *spring* steel *locks* the fastener, resists vibration**

Send for details and samples, or write us about *your* fastening problem.

Our Mr. Smith supervises Multi-Header design . . .



the most versatile glass-metal seal



Constant Multi-Header design development enables Hermetic to offer a Vac-Tite* Compression Multi-Header to suit every design and application requirement.

If requirements call for *4 to 28* solid or tubular terminal Multi-Headers with O.D.'s that range from .375 to 1.125 diameters, Hermetic Headers of "all-glass" or "individual-glass" construction can be supplied. However, to meet the most difficult specifications, Hermetic can provide Multi-Headers *as large as you specify with as many terminations as is required* in "individual-glass" construction and solid metal body.

Consult Hermetic for standard, as well as specially designed headers, with or without mounting studs, that act as cover and seal.

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*VAC-TITE is Hermetic's new vacuum-proof, compression construction, glass-to-metal seal.

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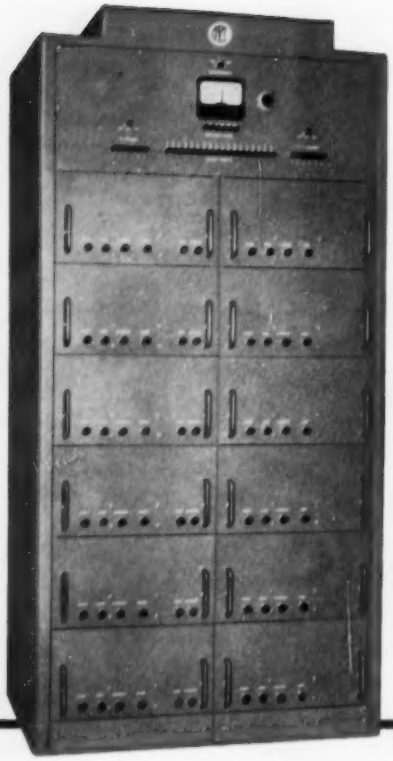

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because it has special high speed features for computing center work!"

The MC-700 AM-FM Electronic Multiplier is extremely accurate and performs at very high speed, thus saving many hours monthly in all types of computing center work. It consists of:

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- 12 identical "B" units called SLAVES
- Each Master Unit accepts two imputs, X and Y, and provides the product XY
- With the addition of the Slave Units, the products XZ and XW are obtained.

These Specifications of the MC-700 provide four quadrant multiplication:

1. The input and output ranges are plus or minus 100 volts, with an input impedance of greater than one megohm, and an output impedance equal to that of the D-C Amplifier in the unit.
2. The static accuracy is within 0.2 volts over full range.
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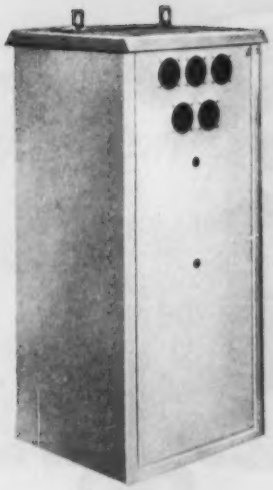

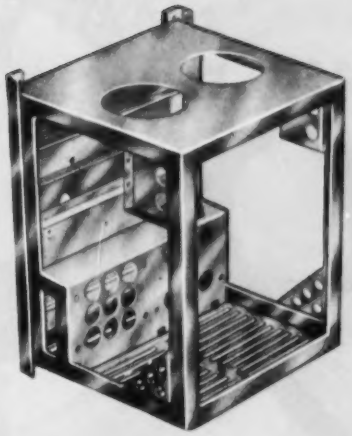

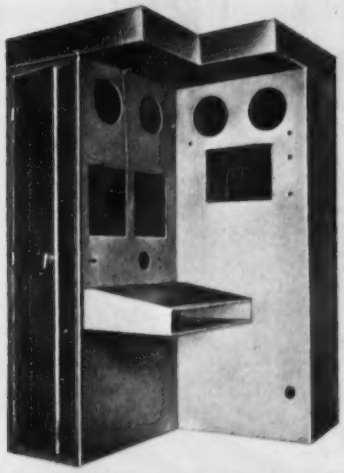

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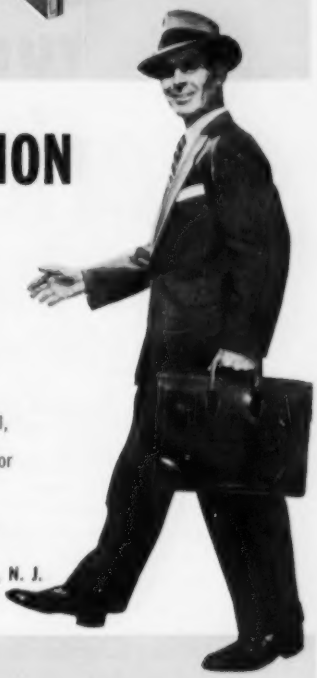
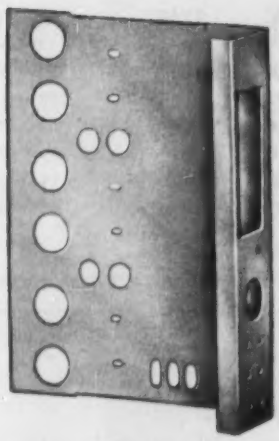
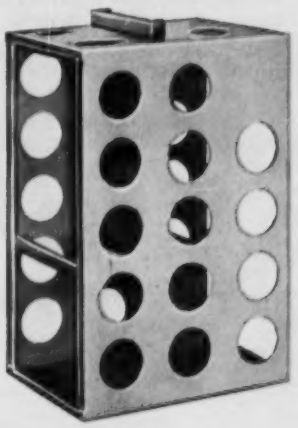
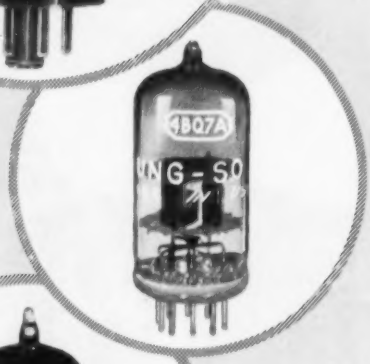


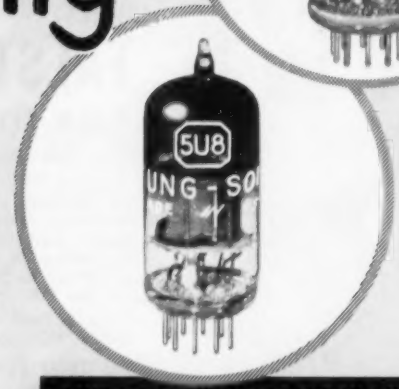




NOW 39 TUNG-SOL "Series String" TV TUBES

For Luxury-Set Performance in the Low-Price Field





This complete line of 600 milliampere tubes, recently augmented by eight *new* types, delivers the performance requirements of present circuit designs as well as any foreseeable new circuitry. Additional tube types are being developed continually.

Rigid standards of quality control insure the same dependable performance from these Tung-Sol Tubes as from the prototypes . . . Experienced Tung-Sol engineering is ready to help you achieve smooth, efficient production . . . Reliable *co-ordinated* deliveries are meshed to meet the exacting schedules of mass manufacturing . . . And your design plans are held in strict confidence.

For additional information, write to Commercial Engineering Department, Tung-Sol Electric Inc., Newark 4, New Jersey.

Sales Offices: Atlanta, Chicago, Columbus, Culver City, Dallas, Denver, Detroit, Montreal (Canada), Newark, Seattle.

TUNG-SOL RADIO · TV TUBES DIAL LAMPS

TUNG-SOL "SERIES STRING" TV TUBES

2AF4	3BZ6	5U8	12E4A
3AL5	3CB6	5V6GT	12BH7A
3AU6	3GS6	6AU7	12BQ6GT
3AV6	4BQ7A	6AU8	12BY7A
3BA6	4BZ7	6AX7	12GA5
3BC5	5AM8	6CG7	12L6GT
3BE6	5AN8	6S4A	12W6GT
3BF6	5AQ5	6SN7GTB	19AU4
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Tung-Sol also produces aluminized picture tubes for series string sets.

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Save assembly time . . . with quality-controlled ceramics

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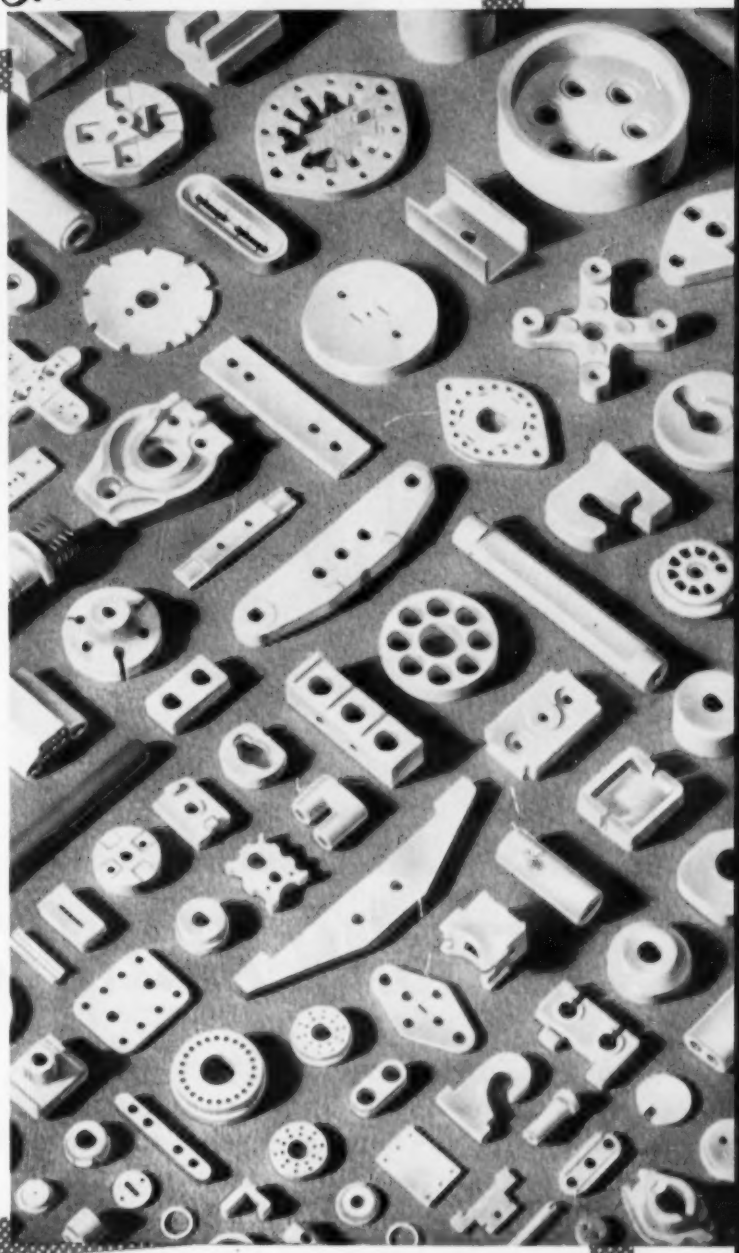
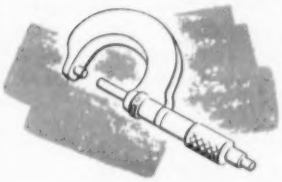
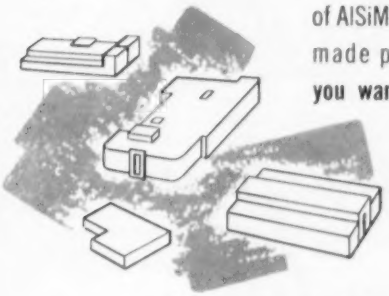


Your line workers will appreciate the ease and speed with which they can assemble AlSiMag ceramics. Your production planning staff will be well pleased with the excellent quality as well as the rapid delivery of these parts.



Physical dimensions and tolerances are checked at every key stage of manufacture by thoroughly trained Quality Control inspectors to insure shipment of a superior product.

Four large, completely equipped plants assure you of hundreds—or hundreds of thousands—of AlSiMag precision made parts **when you want them.**



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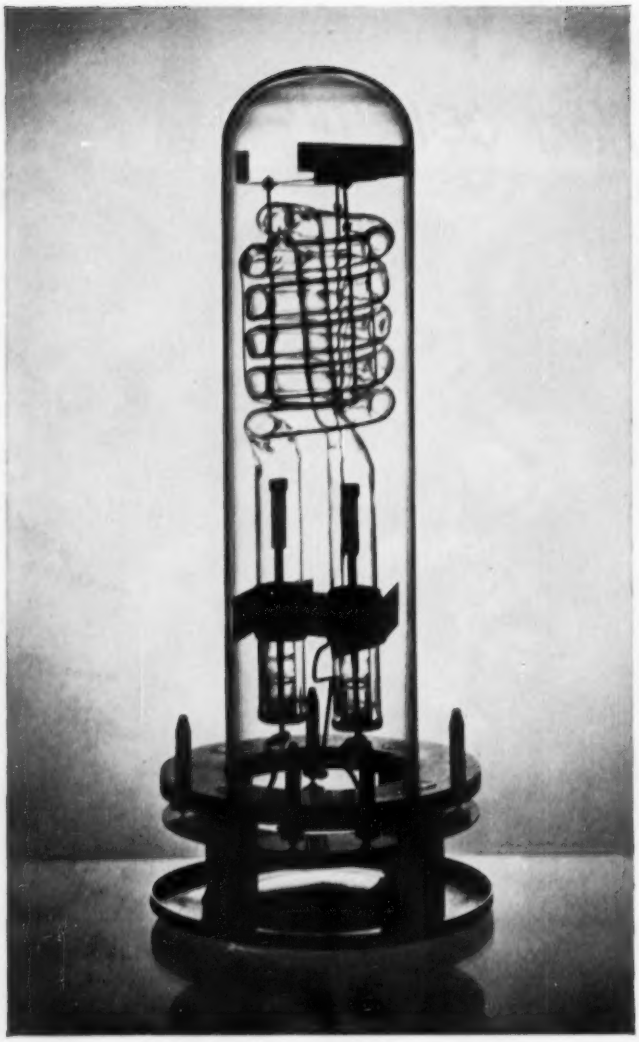

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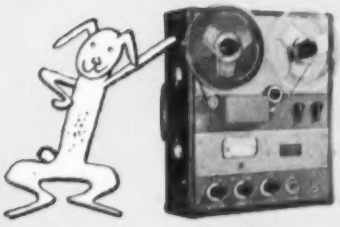
announcing

the new Ampex 610 and 612

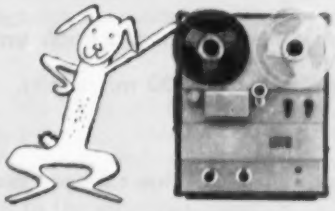
the best now begins at $344...and with this new price comes a smart idea on complete tape equipment for the broadcast or recording studio

Both have all the extraordinary quality and reliability of the Ampex 600 Tape Recorder. They cost less because they are reproducers only. They eliminate chance for accidental erasure—hence are ideal for editing, copying, program auditioning, sales demonstrations and broadcast playback. The Ampex 610 plays half-track and full-track tapes. The 612 plays these and two-track stereophonic as well.

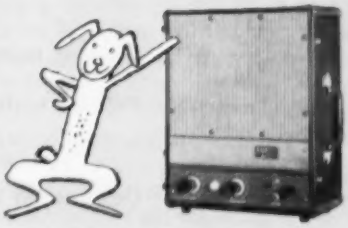
NOW YOU CAN BUY THIS matching family of three FOR THE PRICE OF THE PROFESSIONAL CONSOLE RECORDER



AMPEX 600 — The tape recorder that combines ultra fidelity, timing accuracy, reliability and portability. It has successfully brought the Ampex Standard of Excellence within reach of every broadcast station. Prices are $498 chassis for rack mounting or $545 in portable case.



AMPEX 610 or 612 — The new tape reproducers that have identical characteristics to the Ampex 600. Prices of the 610 (half-track and full-track) are $344 chassis only and $359.50 in portable case or contemporary furniture cabinet. Prices of the 612 (half-track, full-track, and two-track stereophonic) are $379.50 and $395 respectively in same mountings as above.



AMPEX 620 — A companion amplifier-speaker for either 600, 610 or 612 that matches them in portability, appearance and quality. It provides compelling "live sound" demonstrations for selling station programs or spots (and also can be a sensitive station monitor). Prices are $149.50 in portable case, or $169.50 in contemporary furniture cabinet.

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Distribution in principal U.S. cities (listed in your classified directory under "Recording Equipment"); distributed in Canada by Canadian General Electric Company.

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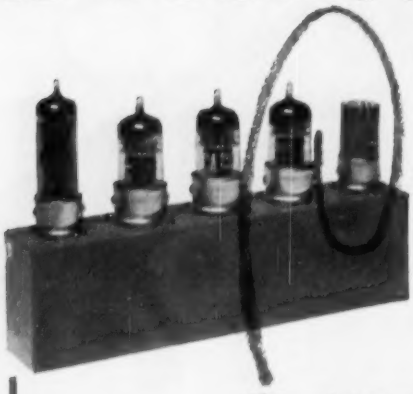


400-CPS AIRPAX CHOPPER PLUGS INTO 7-PIN MINIATURE SOCKET IN THIS COMPACT D-C AMPLIFIER

This miniature 400-cps chopper stands about 1⅜ inches above the chassis, is about ¾ inch in diameter, and can be locked in place in a standard 7-pin tube socket with a tube shield.

Coil excitation of 20 milliamperes is readily obtained from 6.3-volt heater transformer.

Contacts of this single-pole double-throw continuously operating switch are rated for 1 milliampere at 100 volts maximum. On tests at no current—most severe operating condition for life test—units have operated within design limits for well over the rated 2,000-hours life.

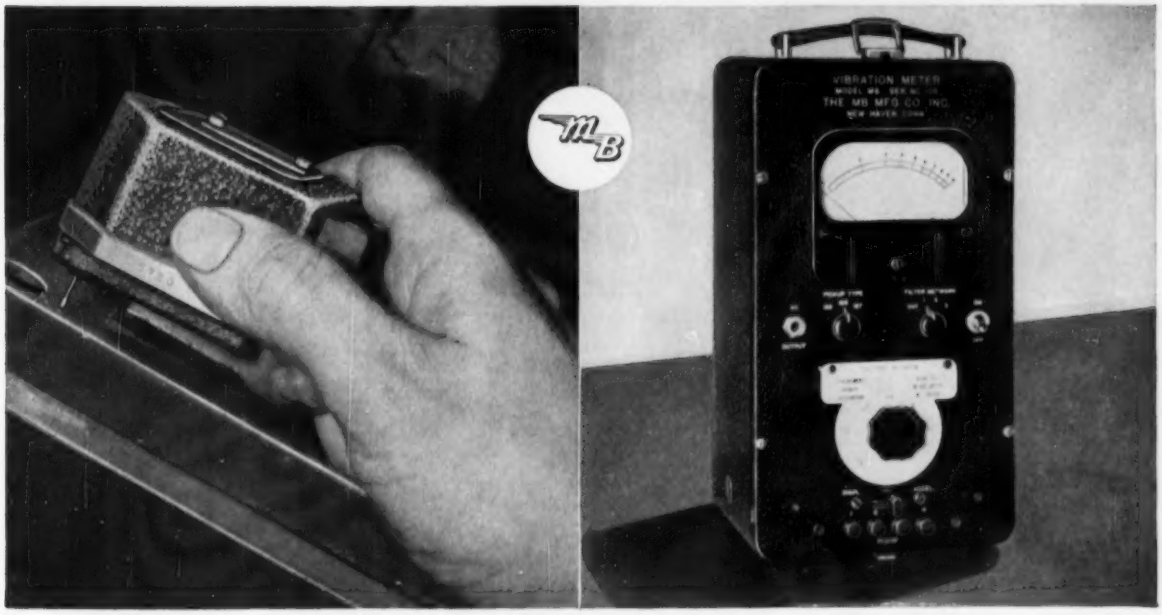
Contact noise across 1 megohm has a peak amplitude of about 1.5 millivolts, an average value of 200 microvolts.

Designated as Airpax Type 300, this chopper provides reliable operation in unusually small space. Consider saving space by using this Airpax Type 300 chopper in your miniature equipment.

For complete specifications write to

AIRPAX
DESIGNERS PRODUCTS COMPANY ENGINEERS
MIDDLE RIVER BALTIMORE 20, MD.

Two new "tools" to help you pin point vibration



MB Probe-type Pickup and Portable Meter

simplify reliable vibration detection and measurement

Here's the pickup that really searches out vibration. It combines the extreme sensitivity of electromagnetic operation with the wide usefulness of a hand-held probing instrument.

With this new MB Type 115 Pickup, you can explore large panels . . . bearings, housing, structural members, bodies large and small. Since the light probe adds negligible loading or weight to the vibrating object, it translates any vibration into voltage with great accuracy for measurement. It lets you pin-point the trouble . . . determine quickly any need for corrective design.

The improved Model M6 MB Vibration Meter teams up with the pickup to give you the facts on vibration. With it, you measure the voltage generated in the pickup directly . . . in useful terms of amplitude, velocity, or acceleration of the vibratory motions.

You can connect as many as four MB Pickups to this meter . . . a selector switch enabling you to read any one at a time. The meter is portable, compact, ruggedized and operates on standard AC.

To lick vibration, you've got to locate it first. You'll find this pair a big help for that job. Write for more data.

the MB *manufacturing company, inc.*

1060 State Street, New Haven 11, Conn.

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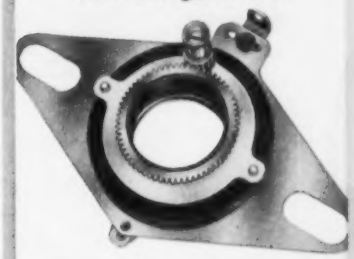
Save!

with

Magnetic Focusing of Picture Tubes

...a typical STACKPOLE Ceramagnet use



Stackpole Ceramagnet rings used as the "heart" of magnetic picture tube focusing units in television sets, spell these advantages:

- Lower material costs by comparison with electrostatic focusing. (Material savings alone run from 50c to $1 in actual instances.)
- Faster, easier, more accurate factory focusing of sets.
- Lower incoming inspection costs because of consistently high quality of magnetic tubes.
- Superior, stable focusing over entire face of large tubes.
- Magnetic focusing readily adapted to use of increased second anode voltages. Less affected by voltage changes.
- Longer tube life.
- Easy service adjustment when tube replacement becomes necessary.

Photo shows unique magnetic focusing unit made by Glaser-Steers Corporation, Belleville, N. J. It uses a single Stackpole Ceramagnet ring 3⅛" in diameter x ½" thick.

new star of the magnetic firmament !

STACKPOLE

Ceramagnet

CERAMIC MAGNETS

Ceramagnet, the unique new Stackpole ceramic magnet, material excels in high resistance, repelling, aging and other essential characteristics. Its cost—well below that of conventional magnetic materials—opens important new engineering horizons wherever positive, highly permanent attracting, repelling or even "cushioning" might be utilized.

Ceramagnet units can be supplied in almost any desired shapes or sizes. Send details of your application for recommendation and samples.

Electronics Components Division

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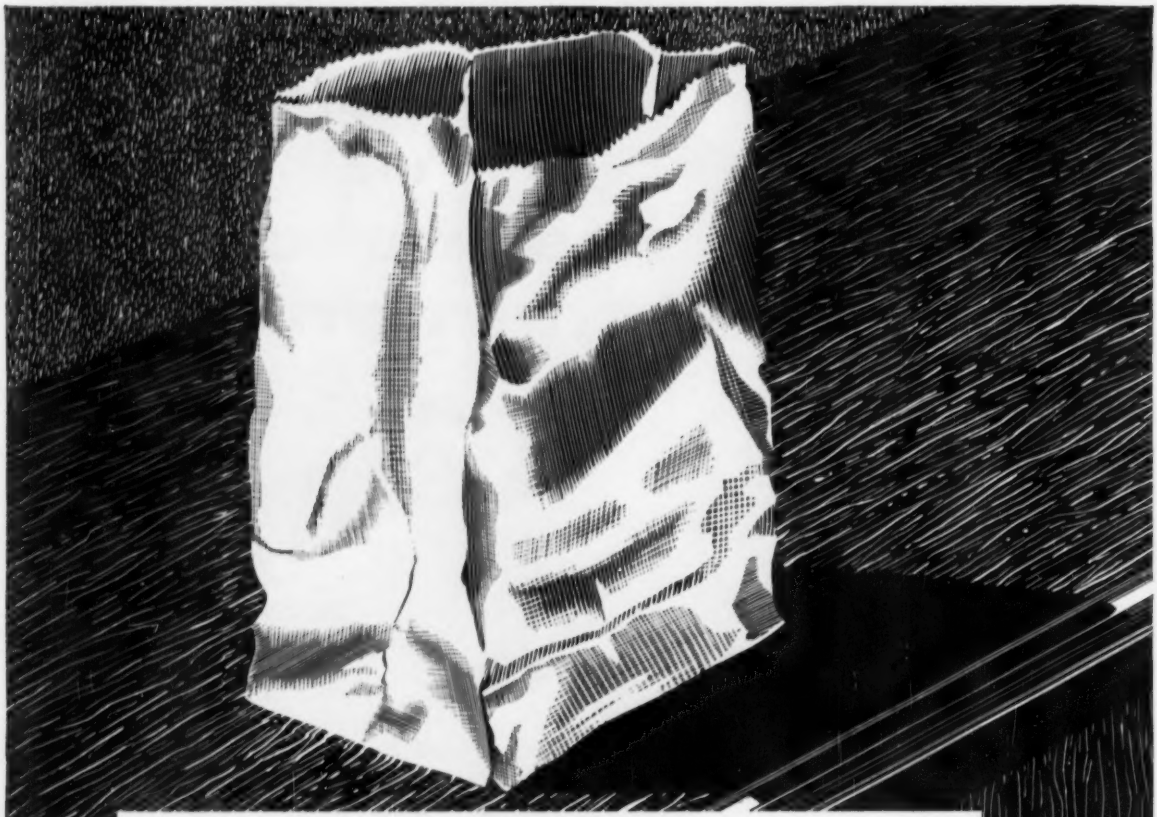
St. Marys, Pa.



...and a pound of precision, please

Those who shop for precision in mixer crystal testing, look for accurate measurement of these characteristics: Relative Noise Figure . . . Relative Sensitivity . . . Crystal Pair Matching . . . Conversion Loss . . . Noise Temperature.

AIL's Type 390A-3 Microwave Crystal Test Set achieves this at the highest standard of operating efficiency. But more important, all this precision comes delivered in a one-pound package, RFU* Field or Laboratory. Priced at $97.00, the unit has been repeatedly selected by those who recognize in all AIL products the individuality of advanced design, which receives universal acceptance.

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A new and important addition to Bomac's line of microwave products is the BL-800/6780 Reflex Klystron.

Rugged and reliable the BL-800/6780 klystron offers improved local oscillator performance and dependability for X-band radar systems.

Unexcelled high altitude operation, without pressurization and ease of installation without disrupting associated components or plumbing is now possible.

Controlled manufacturing procedures and rigid testing standards assure the user electrical uniformity and mechanical stability.

FEATURES

1. Light-weight, rugged construction
2. Low microphonics
3. Rapid warm up
4. Lock-nut tuning
5. Viking connector for convenient installation

GENERAL CHARACTERISTICS

Frequency Range	8.5 to 10.0 kmc
Heater Voltage	6.3 v
Heater Current	1.2 amps

MAXIMUM RATINGS

Resonator Voltage	350 v
Resonator Current	42 ma
Reflector Voltage	0 to −1000 v

MECHANICAL CHARACTERISTICS

Output Connection	Bolts to UG-39/U flange or UG-40A/U choke for 1 x ½ x 0.050 inch waveguide
Base	Molded flexible leads, 7 inch leads terminated in Viking Connector (VP5, 2AA1 plug — VS7, 23C1 hood)
Cooling	Convection
Tuner	Lock-nut

We invite your inquiries regarding
- ENGINEERING
- DEVELOPMENT
- PRODUCTION

Bomac Laboratories, Inc.
BEVERLY, MASSACHUSETTS

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Catalog on request. Write (on your company letterhead) Dept. E-9 BOMAC Laboratories, Inc. Beverly, Mass., or phone Beverly 6800.

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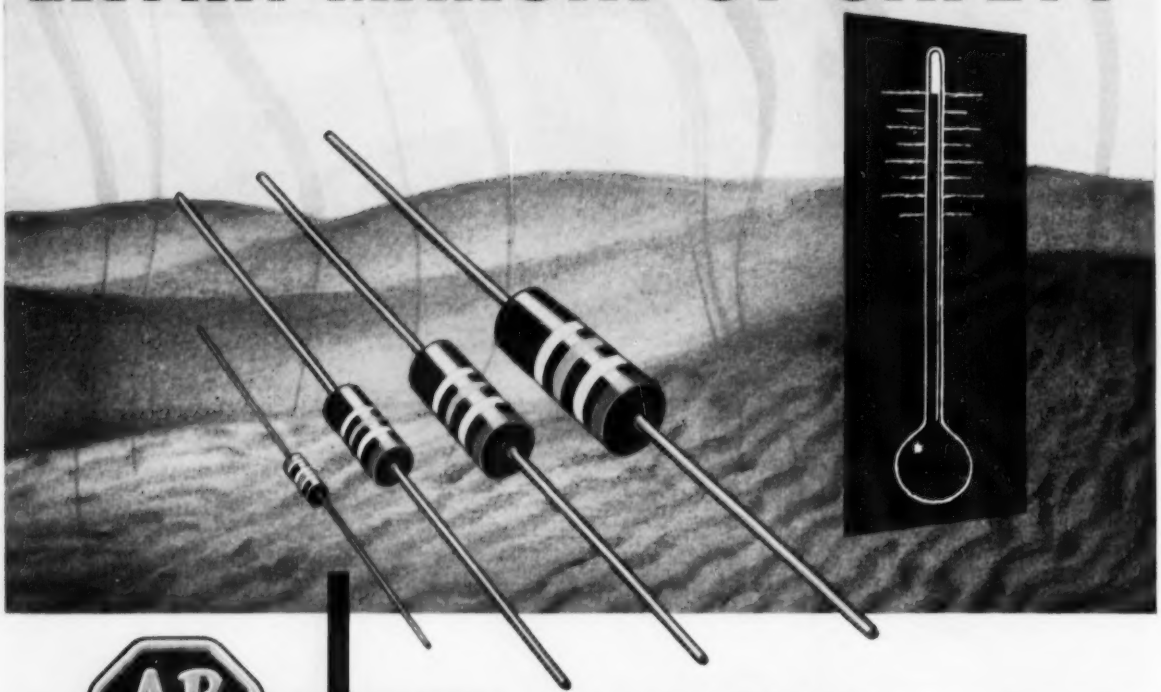
for that

EXTRA MARGIN OF SAFETY



A-B Quality

RATED AT 70C AMBIENT... NOT 40C

Allen-Bradley resistors are packed in patented cartons to prevent the lead wires from becoming bent and tangled.

These Allen-Bradley molded resistors can also be furnished in reels for use in automatic assembly lines.

Allen-Bradley molded composition fixed resistors are so widely recognized for their quality because they can withstand extremes of temperature, pressure, and humidity without deterioration. They are rated to operate continuously at 70C ambient temperature . . . not 40C, as are other resistors.

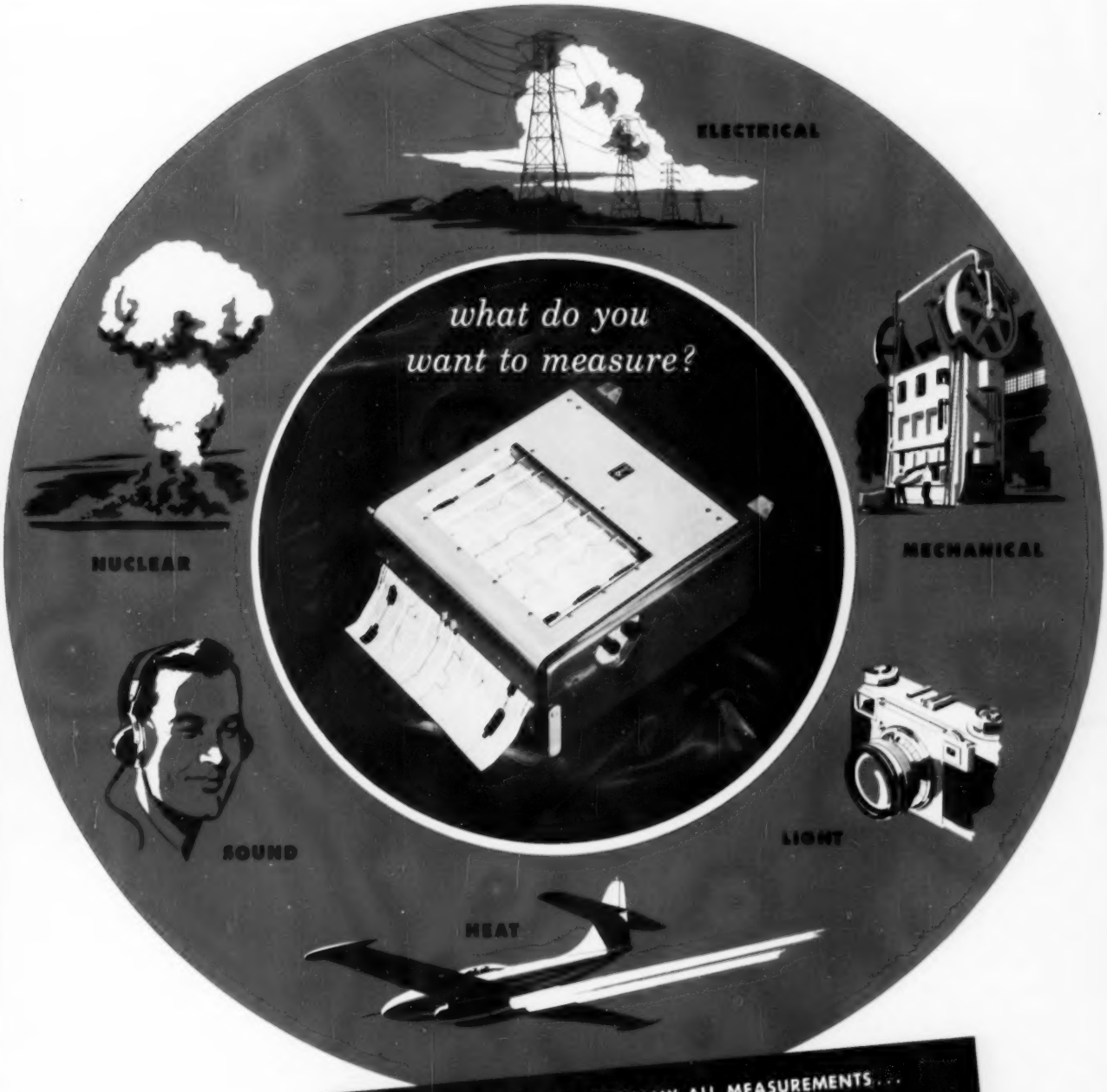
These reliable, uniform resistors are solid molded. They require no impregnation to pass salt-water immersion tests. For an application where the resistor *must not fail,* use Allen-Bradley. Of course, they are also "the best" for all uses and—they cost no more than ordinary resistors.

Allen-Bradley resistors are made in standard RETMA values, in 1/10, 1/2, 1, and 2-watt ratings from 10 ohms to 22 megohms. Write Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis. In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

QUALITY



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BRUSH INSTRUMENTATION

helps you obtain necessary data quickly, easily, in permanent chart form. Designed to simplify analysis.

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BRUSH ELECTRONICS

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

BRUSH RECORDING SYSTEMS OFFER 16 RECORDING SPEEDS, EASE OF USE, INTERCHANGEABILITY

GET THE FACTS and put them in writing with Brush recording systems—designed to give you the greatest flexibility in measurements. Your recorded data will be accurate, legible and permanent. You have a choice of 8 or 16 chart speeds—from 10 inches a day to 10 inches a second—in all systems from a single through multi-channel. An electrically controlled chart drive transmission permits instantaneous switching and remote control.

With the Brush coordinated designs, you can solve many measurement problems with one system.

CONSOLE OR RACK MOUNTED

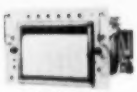
Single, dual, 4 and 6 channel oscillographs and amplifiers all fit standard 19-inch racks; may be obtained with individual covers for portable use.

PORTABLE

Brush portable instruments are designed for rugged service, have the same outstanding features as rack mounting units.

OSCILLOGRAPHS

4 channel



6 channel

1 and 2 channel

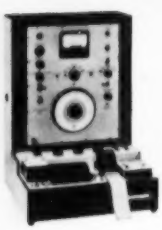
AMPLIFIERS

D.C. amplifier

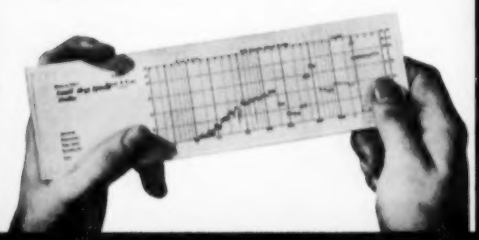
Universal* amplifier

High gain D.C. amplifier

SOUND MEASUREMENT



Brush offers an integrated line of precision equipment for measuring and recording sound, noise, vibration. Typical is the Third-Octave Spectrum Recorder, a self-contained system for simultaneous analysis and recording of vibration and noise.



DIGITAL COUNTING

The Brush Countess* is the lowest-cost high-quality digital counter available, operates on *one-fourth* the power required by conventional counters.

For complete information or bulletins on Brush equipment write: Brush Electronics Company, Dept. 999, 3405 Perkins Avenue, Cleveland 14, Ohio.

*Trade Mark

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MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

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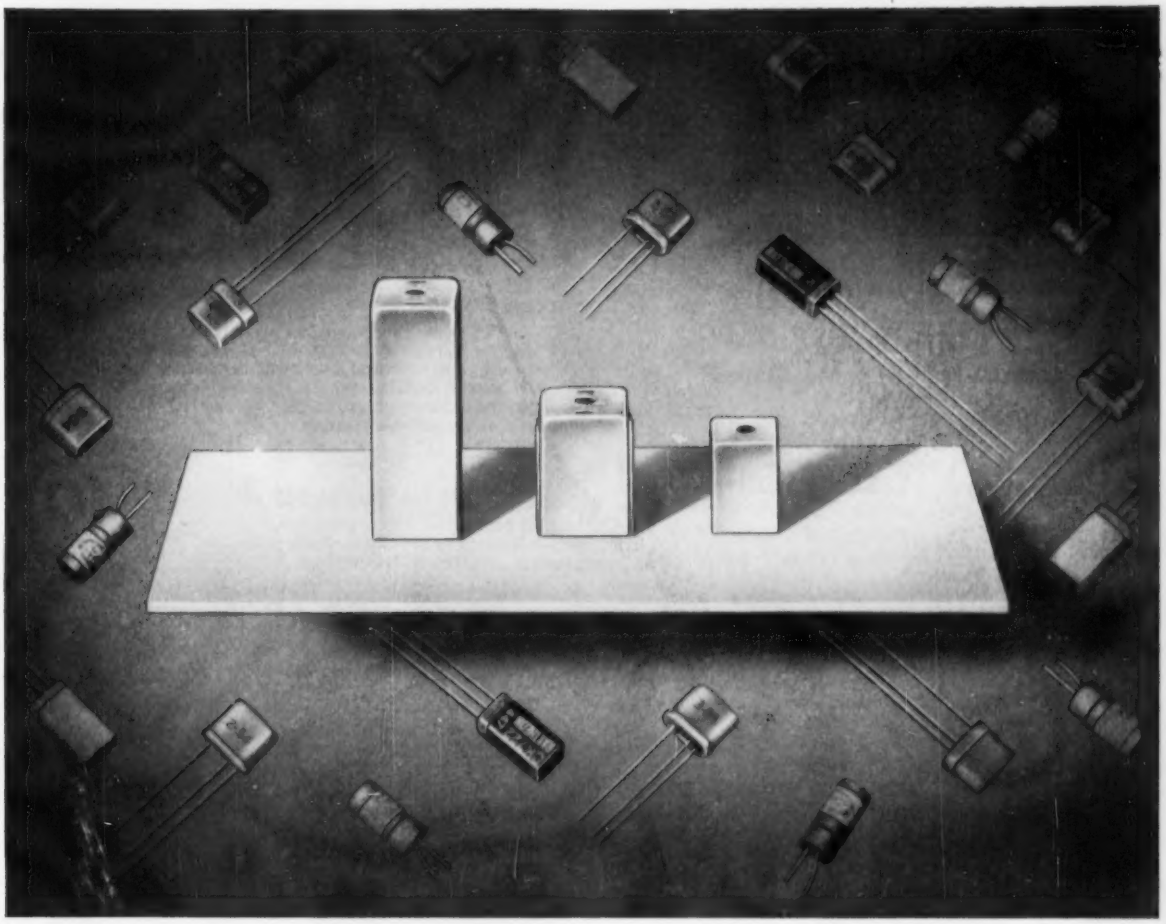

Photo actual size

AUTOMATIC *makes the only complete line of standardized* **TRANSISTOR** *I.F.'s...K-TRANS*

You can order *all* your Transistor I.F.'s from a single source—Automatic Manufacturing Corp. This will save you time and money and give you I.F.'s with the exclusive K-Tran features: *positive threading and controlled torque.* In any electronic miniaturization program, the small physical dimensions, combined with the highest electrical performance of the Transistor K-Trans, give you tremendous advantages.

We make three styles of Transistor K-Trans. Each style has capacity built into the base, and is available in frequencies from 262 KC up through standard frequencies.

From left to right these are the three styles:

STYLE 10. Permits double ended tuning. ($1\frac{17}{32}$ x $\frac{31}{64}$ x $\frac{35}{64}$)

STYLE 12. Permits single ended tuning. ($\frac{31}{64}$ x $\frac{31}{64}$ x $\frac{35}{64}$)

STYLE 15. Specific for severe space limitations. Permits single ended tuning. ($\frac{31}{64}$ x $\frac{13}{32}$ x $\frac{13}{32}$)

Standard size K-Trans ($1\frac{29}{32}$ x $\frac{3}{4}$ x $\frac{3}{4}$) are also available for transistor applications. Since the several types of the K-Tran* I.F. Transformer are all assembled from the same components, they are immediately available for orders of any size.

☆ ☆ ☆

For full engineering information on transistor and other type K-Trans, ask for your copy of the 45-page K-Tran Manual. It will help you design better transistor circuits.

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Subsidiary General Instrument Corporation

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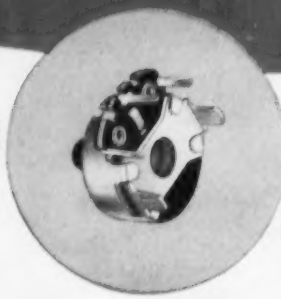
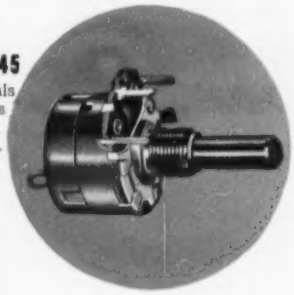
FOR YOUR AUTOMATION PROGRAM

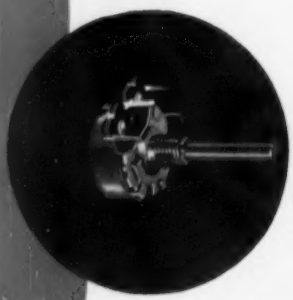
VARIABLE RESISTORS FOR PRINTED CIRCUITS



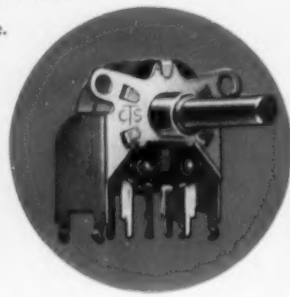
Type UPM-45
For TV preset control applications. Control mounts directly on printed circuit panel with no shaft extension through panel. Recessed screwdriver slot in front of control and 3/8" knurled shaft extension out back of control for finger adjustment. Terminals extend perpendicularly 7/32" from control's mounting surface.

Type GC-U45
Threaded bushing mounting. Terminals extend perpendicularly 7/32" from control's mounting surface. Available with or without associated switches.

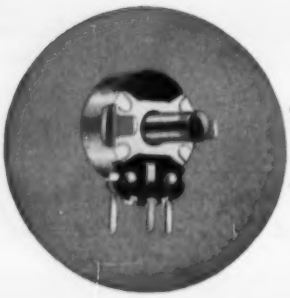




Type U70 (Miniaturized)
Threaded bushing mounting. Terminals extend perpendicularly 5/32" from control's mounting surface.

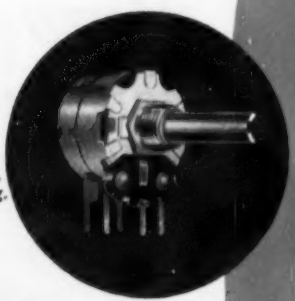


Type YGC-B45
Self-supporting snap-in bracket mounted control. Shaft center spaced 29/32" above printed circuit panel. Terminals extend 1-1/32" from control center.

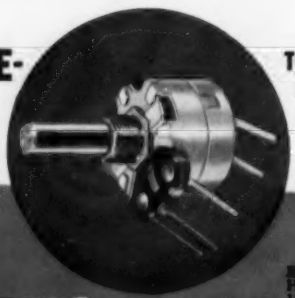


Type XP-45
For TV preset control applications. Control mounts on chassis or supporting bracket by twisting two ears. Available in numerous shaft lengths and types.

Type XGC-45
For applications using a mounting chassis to support printed circuit panel. Threaded bushing mounting.



VARIABLE RESISTORS FOR SOLDERLESS "WIRE-WRAP" CONNECTIONS



Type WGC-45
Designed for solderless wire-wrapped connections with the use of present wire-wrapping tools. Available with or without switch and in single or dual construction.

The controls illustrated are typical constructions. CTS' years of engineering and technical experience makes available many other types for your automation needs.

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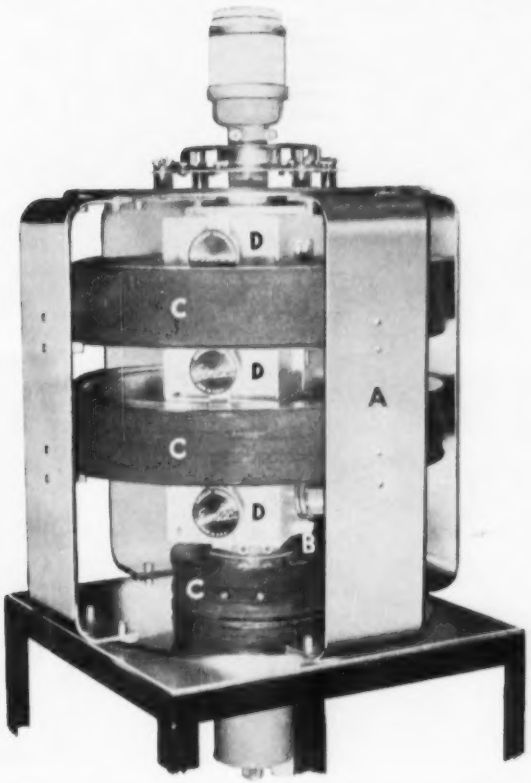
The Exclusive Specialists in Precision Mass Production of Variable Resistors

Eimac Amplifier Klystrons and Circuit Components

—the easy, economical approach to high power, UHF/microwave transmitters

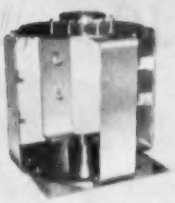


Design and construction of a high power UHF/microwave transmitter for beyond-the-horizon communication and other microwave applications is simple and straight-forward with an Eimac amplifier klystron and circuit components. In fact, it's easier to build than a low frequency Class C amplifier. Eimac high power amplifier klystrons, plus Eimac circuit components consisting of A) Magnetic framework B) RF output load coupler C) Magnetic beam-control coils and D) Convenient tuning wide range RF resonant cavities comprise the essential elements of a final amplifier package. By adding conventional power supplies, control circuits, driver and cabinets to the Eimac klystron-circuit component package, high power at UHF is easily obtained. Eimac developed klystron and circuit components provide equipment manufacturers with the easy economical approach to high power microwave transmitters. In many cases, existing low power equipment can be used as a driver for the higher powered amplifier.

Radio Frequency circuitry is completed outside the vacuum system of Eimac klystrons through circuit components. This allows unmatched economy by eliminating repurchase of costly RF circuitry with each tube replacement.

The reliability and performance of Eimac klystrons is proven, as they were employed extensively in established microwave scatter-type communication systems.

For an easy and economical approach to reliable high power microwave transmitting equipment, investigate the incomparable capabilities of performance-proved Eimac developed klystrons and klystron circuit components.



A **Magnetic frame work**

B **Output load coupler**

C **Magnetic beam-control coils**

D **Resonant cavities**

EIMAC AMPLIFIER KLYSTRONS

	FREQUENCY RANGE—MC	CW POWER
3K3000LA	400-600	2000w
3K3000LQ	760-980	2000w
3K20,000LA	470-580	5000w
3K20,000LF	580-720	5000w
3K20,000LK	720-890	5000w
3K50,000LA	470-580	10,000w
3K50,000LF	580-720	10,000w
3K50,000LK	720-890	10,000w
3K50,000LQ	850-1000	10,000w
4K50,000LQ	750-1000	10,000w

For further information write our technical service department.

EITEL-McCULLOUGH, INC.
SAN BRUNO • CALIFORNIA
World's Largest Manufacturer of Transmitting Tubes

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or *ANY* MAGNETIC MATERIALS JOB . . .

Write for your Copy
"MAGNETIC MATERIALS"

This 32-page book contains valuable data on all Allegheny Ludlum magnetic materials, silicon steels and special electrical alloys. Illustrated in full color, includes essential information on properties, characteristics, applications, etc. Your copy gladly sent free.
ADDRESS DEPT. E-69

You can *rely* on core materials like the Allegheny 4750 components illustrated above, in your receivers, recording heads or microphone assemblies.

In fact, whether your equipment is small or large, the extra-broad line of A-L magnetic materials will solve your magnetic core problems. It includes all grades of silicon steel sheets or coil strip, as well as Allegheny Silectron (grain-oriented silicon steel), and a wide selection of high-permeability alloys such as 4750, Mumetal, Permendur, etc.

Our service on these materials also includes complete facilities for the fabrication and heat treatment of laminations. (For users of electrical sheets and strip, our lamination know-how is a real bonus value!) Either way, we'll welcome the chance to serve you. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

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AL
STEELS FOR THE ELECTRONIC AGE

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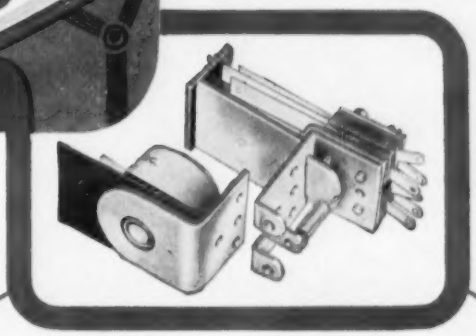
7 contact assemblies and
11 *Interchangeable* coils
enable you to build a sample

GUARDIAN®

SERIES 200 RELAY

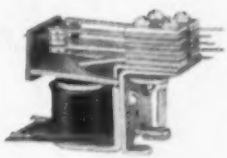
for Development Purposes



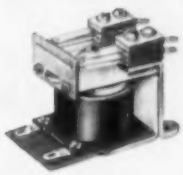
Ideal for Testing and Experimenting

Available at your local electronic parts distributor

Guardian Series
A. C. 100 D. C.

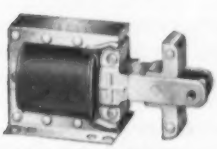


Guardian Series
A. C. 600 D. C.



Your distributor can supply Series 200 Relays in quantities up to 100 units. For larger production runs of completely assembled, adjusted and tested relays, we recommend the Guardian Series 100 A.C., Series 105 D.C., Series 600 A.C., or Series 605 D.C., listing the same specifications as used to make up your Series 200 production sample.

NO. 1 SOLENOID



NO. 16 SOLENOID

The complete GUARDIAN SERIES 200 RELAY parts assortment includes 7 Contact Assemblies and 11 Coils all of which are completely *interchangeable*. Contact assemblies vary from SPDT to 4PDT standard or midget size with contacts rated at 8 or 12½ amperes. Coils range from 6 v. A.C. to 230 v. A.C. and 6 v. D.C. to 110 v., D.C. plus a 5000 ohm plate coil. All you do is select the rated coil and contact assembly you require, fasten these together with a screwdriver and you have a top quality, correctly rated, *production sample* Guardian Relay. Test it. Examine it thoroughly and critically. Then order your production quantities. Ask your local electronic parts distributor about other Guardian industrial type relays, steppers, solenoids and ratchet relays, or write direct for further details.

MS-115 STEPPER

RC-100 RATCHET RELAY

See Your Local Parts Distributor for RELAYS, SOLENOIDS, STEPPERS and RATCHET RELAYS

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1625K W. WALNUT STREET CHICAGO 12, ILLINOIS
A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

NEW HIGH STANDARDS OF CAMERA-TUBE PRODUCTION

Extreme delicacy in processing parts for G-E camera tubes is shown as this glass technician fabricates an image-orthicon target. The glass bubble she holds is only 1/10,000 inch thick. After cutting out a small section, she seals this carefully to a metal ring. Any slip or other false movement would completely ruin the fragile target.

Without aid from magnification, the human eye cannot see the openings (250,000 to a square inch) in this copper mesh for a G-E image orthicon—shown here being welded to its ring. Note the rubber finger cots used by the General Electric worker, to avoid contaminating the silk-fine mesh!

Target and mesh are assembled, then riveted together with a spacing of 1/500 inch, to form a link between optical image and electrical signal. A single dust particle could mar tube performance; so before work starts, these G-E specialists sit quietly for ten minutes, to permit any dust to settle that may remain in the air after filtering and conditioning.

18-inch offset screwdrivers are used to tighten the set-screws holding target and mesh assembly in place in the camera tube. Skill, care, and time are needed to complete the delicate operation. Again, dust and lint are barred. An important step toward cleanliness, is the lint-free Nylon garments worn by all persons in the G-E camera-tube area.

CRAFTSMANSHIP FEATURE BY GENERAL ELECTRIC!

To include image orthicons, vidicons, other commercial and military types.

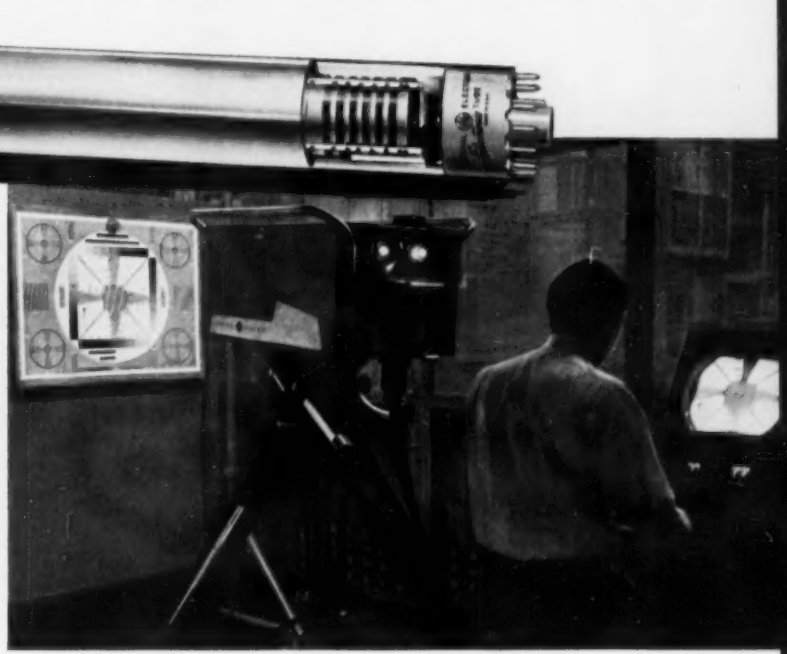
G.E.'s entry into camera-tube manufacture is a project of major proportions. Extensive facilities and advanced equipment have been acquired; impressive engineering and technical skills have been assembled; workers have been exhaustively trained.

The purpose is high-quality, long-life camera tubes *of all types*—from TV image orthicons, now in full G-E production, to vidicons and other "seeing" tubes for commercial and military uses.

How improved performance is built into G-E camera tubes, these pictures show in part. Every operation described is rivalled by numerous others that call for the same or greater precision.

You are invited to familiarize yourself with G-E camera-tube manufacture, by written request for information. Problems involving camera tubes to meet your special design needs, will be welcomed. *Tube Dept., General Electric Co., Schenectady 5, N. Y.*

Powerful lenses aid trained hands. In building G-E camera tubes, numerous precision operations call for the aid of microscopes. Here a micro-drill operator drills a 1/500-inch hole—less than the diameter of a hair—for the beam-limiting aperture in the first dynode of a G-E image orthicon tube.



Final testing of a G-E image orthicon uses actual performance as the yardstick. Instrumentation supplements the verdict of the inspector's critical eyes. Life tests, under the most unfavorable conditions, also are regularly conducted by General Electric, to increase the service life and improve the performance of all G-E camera tubes . . . Above: a G-E image orthicon—Type GL-5820—ready for the TV camera.

Progress Is Our Most Important Product

GENERAL ELECTRIC

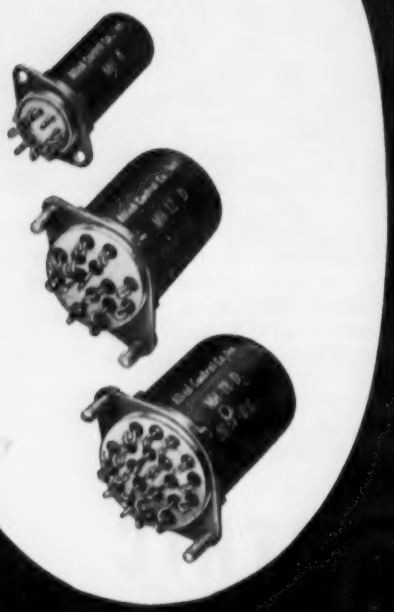
162-184

NEW

additions to ALLIED CONTROL'S

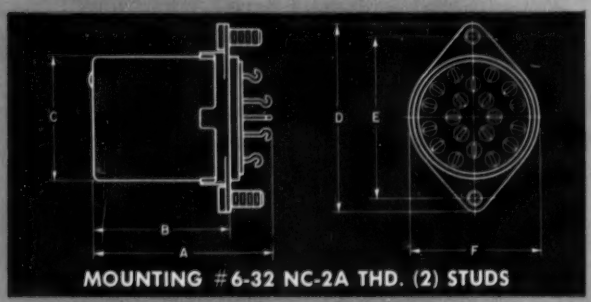
MH LINE

THE ALLIED **ORIGINAL** MH SERIES



Allied Type MHJ • Performance Data

CONTACT RATINGS	Low level up to 2 amperes at 29v d-c or 115v a-c (non-inductive) Max. Contact Drop: 1 millivolt
CONTACT ARRANGEMENT	MHJ-12D: 4 PDT MHJ-18D: 6 PDT
COIL	MHJ-12D 26.5v d-c: 250 ohms resistance MHJ-18D 26.5v d-c: 200 ohms resistance (Other resistances are available.)
TEMPERATURE	Minus 65°C to plus 125°C
VIBRATION	10-55 cps at 0.125 inch double-amplitude 55-2000 cps at 20g
OPERATING SHOCK	100g
ALTITUDE	Sea level to 80,000 feet
WEIGHT	MHJ-12D: 3.0 ounces MHJ-18D: 4.2 ounces
OVERALL DIMENSIONS	MHJ-12D: 1-3/4 max. x 1-3/64 diameter MHJ-18D: 1-3/4 max. x 1-3/16 diameter
MILITARY SPECIFICATIONS	Meets tests conditions of MIL-R-5757B, MIL-R-6106A and MIL-R-25018

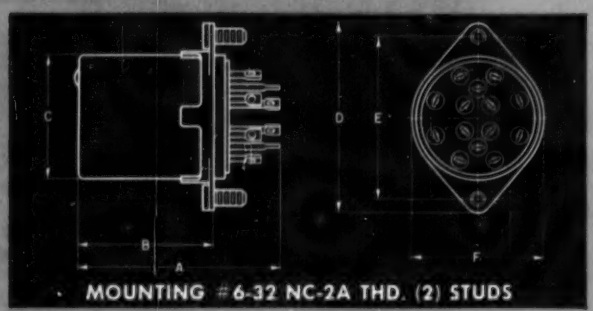


MOUNTING #6-32 NC-2A THD. (2) STUDS

	A	B	C	D	E	F
MHJ—12D	1⅜ max.	1⅛	1¼	1²⁵⁄₆₄	1.406	1⅛
MHJ—18D	1¾ max.	1⅛	1⅜	1¹⁵⁄₁₆	1.562	1¹³⁄₁₆

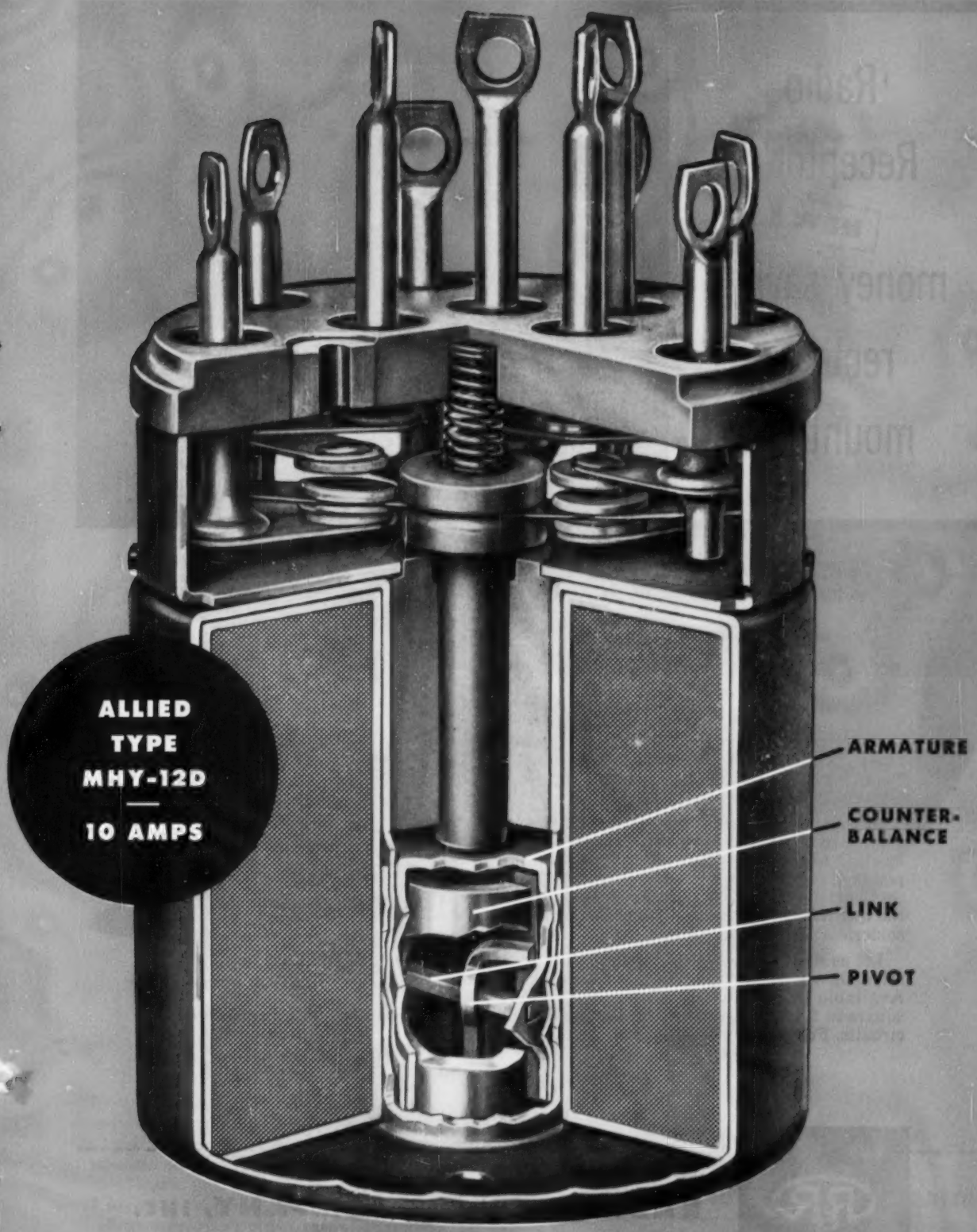
Allied Type MHY • Performance Data

CONTACT RATINGS	10 amperes at 29v d-c or 115v a-c (non-inductive)
CONTACT ARRANGEMENT	MHY-6D: 2 PDT MHY-12D: 4 PDT
COIL	MHY-6D 26.5v d-c: 250 ohms resistance MHY-12D 26.5v d-c: 200 ohms resistance (Other resistances are available)
TEMPERATURE	Minus 65°C to plus 125°C
VIBRATION	10-55 cps at 0.125 inch double-amplitude 55-2000 cps at 20g
OPERATING SHOCK	100g
ALTITUDE	Sea level to 80,000 feet
WEIGHT	MHY-6D: 3.0 ounces MHY-12D: 4.2 ounces
OVERALL DIMENSIONS	MHY-6D: 1-25/32 max. x 1-3/64 diameter MHY-12D: 1-63/64 max. x 1-3/16 diameter
MILITARY SPECIFICATION	Meets tests conditions of MIL-R-5757B, MIL-R-6106A and MIL-R-25018



MOUNTING #6-32 NC-2A THD. (2) STUDS

	A	B	C	D	E	F
MHY—6D	1²⁵⁄₃₂ max.	1⅛	1¼	1²⁵⁄₆₄	1.406	1⅛
MHY—12D	1⁶³⁄₆₄ max.	1⅛	1⅜	1¹⁵⁄₁₆	1.562	1¹³⁄₁₆

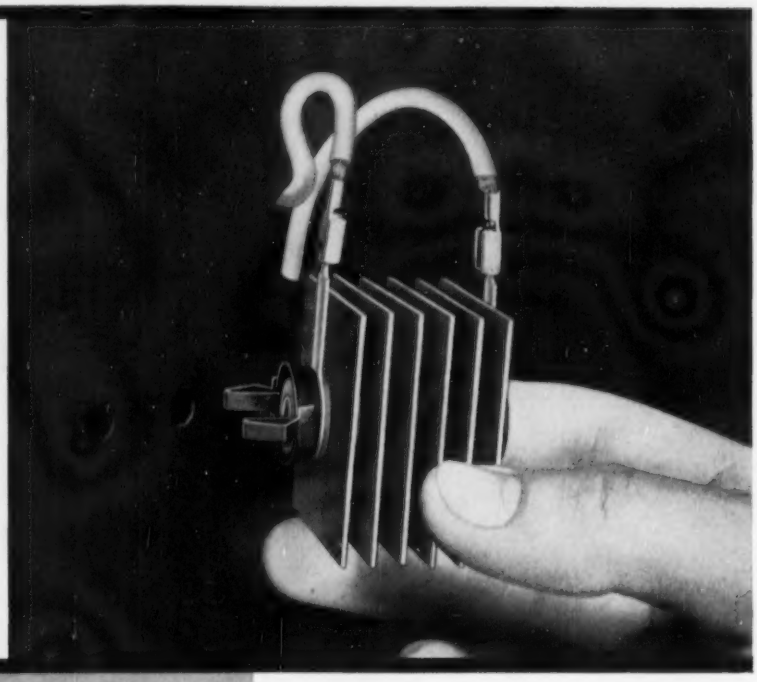


ALLIED CONTROL

ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N.Y.

AL 184

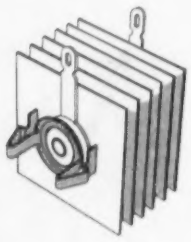
Radio Receptor's NEW money saving rectifier mounting!



"QUI-KLIP" *snap-in type* SELENIUM RECTIFIERS

QUICK MOUNTING! QUICK REMOVAL!

Spring steel clips with safe edges snap into two round, large tolerance holes in chassis (approx. ¾" dia., ¾" c. to c.). Solderless connectors as shown, when used, simplify servicing



Radio Receptor's unique QUI-KLIP rectifiers will soon make their debut in TV sets produced by one of the country's leading manufacturers, saving them countless dollars in production costs.

QUI-KLIP requires no tools or sockets for mounting. There are no studs to break or threads to strip and the locating tab is now unnecessary. QUI-KLIP provides a positive seat for the rectifier – no rocking. Yet any serviceman can remove the stack quickly by squeezing the QUI-KLIP prongs with his fingers and removing the solderless connectors.

Let us show you how to put the cost saving QUI-KLIP selenium rectifiers to work in *your* production . . . Available in most popular sizes with cells from 1" square to 2" square, for radio, TV and other electronic circuits. For detailed information, write Dept. E-10

- Speeds assembly time.
- Slashes production costs.
- Simplifies assembly.
- Eliminates stud rejects (No studs or nuts needed.)
- Permits easier replacement in the field.

Really RR Reliable

Semiconductor Division

RADIO RECEPTOR COMPANY, INC.

In Radio and Electronics Since 1922

SALES OFFICES: 251 WEST 19TH ST., NEW YORK 11, N. Y., WAtkins 4-3633 • Factories in Brooklyn, N. Y.

SELENIUM RECTIFIERS, THERMATRON DIELECTRIC HEATING GENERATORS AND PRESSES, COMMUNICATION, RADAR AND NAVIGATION EQUIPMENT

REVERE

ROLLED
Printed Circuit Copper

No longer need the lack of material deter you from switching to printed circuitry. Revere *Rolled* Printed Circuit Copper is now available to laminators in standard coils of 350 lbs. in widths up to 38″, and in .0015″ and .0027″ gauges weighing approximately 1 oz. and 2 oz. per square foot.

Revere *Rolled* Printed Circuit Copper is accurate in gauge, of high conductivity, and uniform density. It is easily etched and soldered.

The next time you order blanks from your laminator, specify Revere *Rolled* Printed Circuit Copper.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

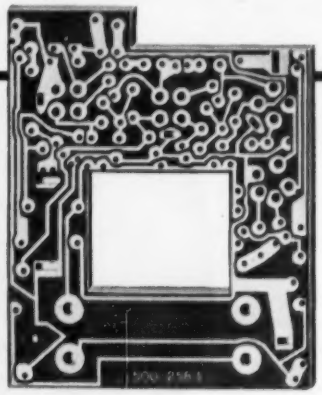
• • •

Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

FIRST TRANSISTOR RADIO MADE POSSIBLE

. . by INSUROK® copper-clad printed circuits!

Here's a remarkable example of miniaturization . . made possible mainly through the use of printed circuits and transistors. This diminutive radio weighs a scant 12 ounces, complete with battery. Yet, it has good tone, is selective, and delivers plenty of volume.



Here's the printed-circuit board used in the Regency . . made with Richardson T-725 copper-clad INSUROK. Engineers of I.D.E.A., Inc. of which Regency is a division, laid out the circuit. Croname, Inc.* Chicago, took it from there . . printed the complex circuit on Richardson T-725 copper-clad INSUROK, then etched it. Results: a lightweight, compact, efficient circuit . . tedious, time-consuming wiring eliminated . . faster assembly.

Many grades of Richardson laminate INSUROK are available copper-clad on one or both surfaces. We invite your inquiry.

**Here's what Croname has to say about T-725 copper-clad INSUROK, "Quality is superior . . service good. And Richardson gives us helpful engineering assistance."*

Ask for descriptive bulletin, "INSUROK Copper-Clad Laminates."

RICHARDSON
Laminated and Molded Plastics

The RICHARDSON COMPANY

FOUNDED 1858

2797 Lake St., Melrose Park, Ill. (Chicago District)

SIX PLANTS: Melrose Park, Ill. • Indianapolis, Ind. New Brunswick, N. J. • Newnan, Ga. • Tyler, Tex. • Ogden, Utah

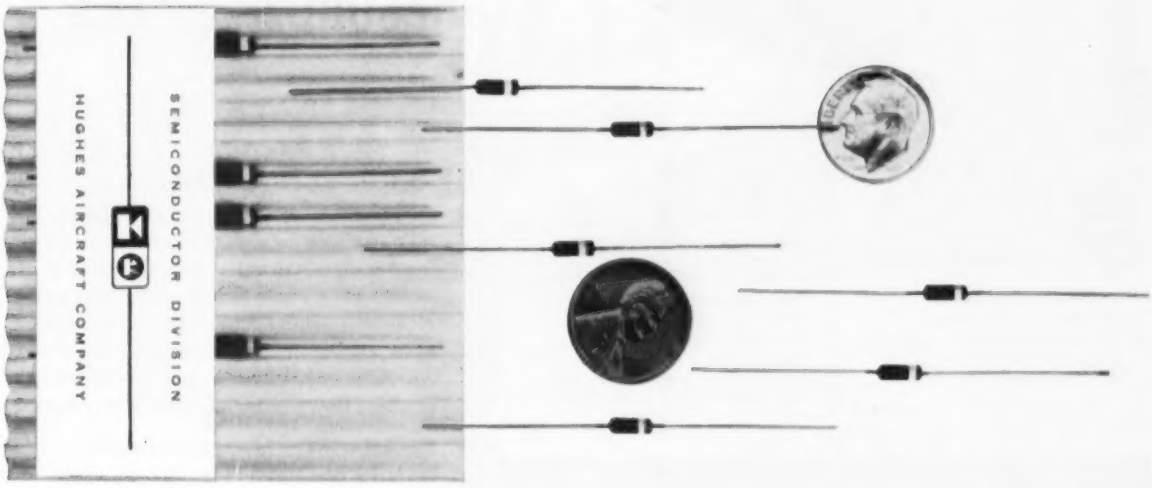
SALES OFFICES IN PRINCIPAL CITIES

Highest

quality...

reliability...

HUGHES SILICON JUNCTION DIODES



Actual Size

features:

HIGH TEMPERATURE OPERATION*
EXTREMELY HIGH BACK RESISTANCE
VERY SHARP BACK VOLTAGE BREAKDOWN
NO VOLTAGE DERATING AT HIGH TEMPERATURE
EXCEPTIONALLY STABLE CHARACTERISTICS
ONE-PIECE, FUSION-SEALED GLASS BODY
AXIAL LEADS FOR EASY MOUNTING
SUBMINIATURE SIZE**

The one-piece, fusion-sealed glass body is impervious to penetration by moisture or other external contamination—*ensures* electrical and mechanical stability. Shipments—*in quantity*—of all types of Hughes Silicon Junction Diodes are now being made in new, compact volume packaging. When your circuit requirements call for diodes with high temperature or high back resistance characteristics, be sure to specify Hughes Silicon Junction Diodes. They are first of all—for RELIABILITY. Listed and described in Bulletin SP4.

*Characteristics rated at 25° C and at 150° C. Ambient operating range, −60° C to +200° C.

**Actual dimensions, diode glass body—Length: 0.265-inch, max. Diameter: 0.105-inch, max.

HUGHES | **SEMICONDUCTOR DIVISION**

Aircraft Company, Culver City, California

New York Chicago Los Angeles

Want more information? Use post card on last page.

introducing

Actual size of G-10 Graphic Recorder is 10" wide x 7⅛" high x 8" deep.

EXCEPTIONAL VERSATILITY AT A PRACTICAL PRICE

THE VARIAN MODEL G-10 GRAPHIC RECORDER... $295

DESIGN FEATURES

Compact . . . weighs less than 15 pounds

Rectilinear trace representation . . . eliminates necessity for curved chart grids

High input impedance . . . minimizes loading effects

Unitized construction . . . chart drive and servo unit are separately available

Chopper Amplifier . . . gain at a.c. minimizes drift

Chart drive shaft extension . . . increases flexibility by allowing synchronization with other equipment

Full chart zero positioning . . . allows placement of pen zero position anywhere on chart

Panel damping control . . . provides optimum system stability through wide range of driving impedances

ELECTRICAL CHARACTERISTICS

Response time	2.5 sec. full-scale
Sensitivity	100 millivolts full-scale
Measurement accuracy	1%
Trace reproducibility	0.5% full-scale
Signal source resistance	0.5 megohm max.
Line requirements	105-125 volts a.c., 35 watts, 60 cps

MECHANICAL CHARACTERISTICS

Maximum pen travel	7 inches
Normal pen travel	5 inches
Servo output torque	1 inch-lb @ ½ rps
Available chart speeds	4 inches per minute
	2 " " "
	40 inches per hour
	16 " " "
	4 " " "

This new, portable Varian Graphic Recorder meets the growing need for a compact instrument to record phenomena capable of representation by d.c. millivolt signals. It's flexible – has widespread applications when used directly as a recording millivoltmeter and – with appropriate transducers – to record pressure, light intensity, temperature and many other physical quantities for which continuously recorded measurement is desired.

Operation – The Model G-10 Graphic Recorder operates on the principle of the self-balancing potentiometer. The recorder is actually a miniature servo system, in which a servo motor rotates a potentiometer to produce a d.c. voltage which exactly cancels the applied d.c. signal voltage. This action determines the position of the writing pen.

Write for complete technical data and price information . . . on this remarkable new instrument and its full line of accessories, priced well within the limits of a modest equipment budget.

Options . . . full-scale response time of 1.0 second and/or full-scale deflection sensitivity of 50 d.c. millivolts may be ordered at slight additional cost. A two-speed Chart Drive is also available to provide instantaneous selection of either of two speeds.

Delivery . . . Standard units generally available from stock.

THE MARK OF LEADERSHIP

SPECIAL PRODUCTS DIVISION

VARIAN associates

PALO ALTO 1, CALIFORNIA

Representatives in principal cities

KLYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, R. F. SPECTROMETERS, MAGNETS, STALOS, UHF WATERLOADS, MICROWAVE SYSTEM COMPONENTS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

British equipment manufacturers are making a vital contribution to the development of electronics in all fields of application.
Their products are being exported to every corner of the world, earning a universal reputation for advanced techniques and excellent performance.
The majority of these electronic equipment manufacturers consistently use Mullard tubes. This choice is decided upon because they prefer the greater assurance of efficiency and dependability, and because the vast manufacturing resources of the Mullard organisation guarantee ready availability of Mullard tubes wherever they are needed.

Write to the undermentioned distributors for full details of Mullard tubes:—

In the U.S.A. International Electronics Corporation,
Department E9,
81, Spring Street, N. Y. 12, New York, U.S.A.

In Canada Rogers Majestic Electronics Limited,
Department 1A,
11-19 Brentcliffe Road, Toronto 17, Ontario, Canada.

Mullard
Electronic Tubes
used throughout the world

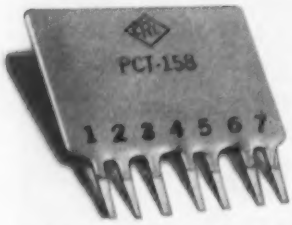
MULLARD OVERSEAS LTD., CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, ENGLAND

Mullard is the Trade Mark of
Mullard Ltd., and is registered in most of the principal countries of the world.

MEV 25

Want more information? Use post card on last page.

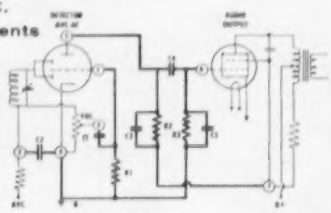
Utilizing modular design for electronic circuitry?



Centralab can help you

— with packaged electronic circuits . . . "tinkertoy" plates . . . authoritative counsel

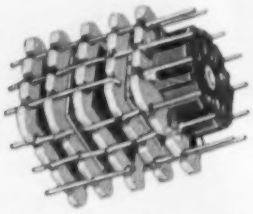
Centralab P.E.C. with 8 components



Planning on "rolling your own" and assembling a circuit from scratch? That's one place Centralab can help you. For Centralab can supply "tinkertoy" plates the way you want them — bare or with components attached.

Or would you rather save design and assembly time, by buying performance, instead of parts? Centralab can help you there, also. Centralab "packages" electronic circuitry — physically reduces a complete circuit, with all wiring, resistors, capacitors, and small inductances, to a two-dimensional form. You save space and weight — and you get a complete, sub-assembly "package" that is tested and guaranteed for specific performance.

Which way should *you* go? Talking it over with Centralab engineering specialists can help you decide, just as it has helped others. But—and this is important—call in Centralab *early* in the planning stage, *before* you've "frozen" your design.



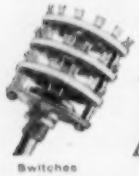
"Tinkertoy" with 8 components

More proof that if it's a job for electronic components, it's a job for Centralab

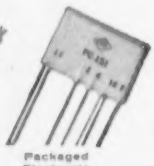
Centralab's advanced engineering continues to create the prototypes of the components industry

Volume Controls

Capacitors



Switches



Packaged Electronic Circuits

Ceramics

NEW THIS MONTH!
Electroni-Kwiz No.7

1st Prize

Matched set of cowhide luggage — including
1. Two-suiter 2. Brief bag

A combination you're proud to own. Like to try for it? Simply answer this question in 50 words, more or less:

If a young man — perhaps your son—wanted to pursue an engineering career in the field of electronics, how would you advise him to prepare for it?

A leading editor will pick the winner of this month's major prize.

Mail your entry to us before September 30.

†Nothing to buy. Employees of Centralab and their advertising agency not eligible. Duplicate prizes awarded in case of tie. Entries become the property of Centralab—none can be returned.

Y-555

Centralab

A DIVISION OF GLOBE-UNION INC.

9141 E. Keefe Avenue • Milwaukee 1, Wisconsin
In Canada: 804 Mt. Pleasant Road, Toronto, Ontario

*Trademark

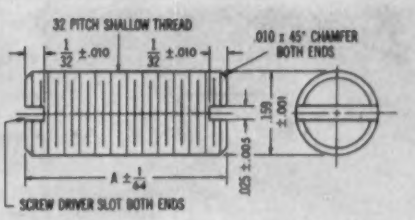
SINCE 1922, INDUSTRY'S GREATEST SOURCE OF STANDARD AND SPECIAL ELECTRONIC COMPONENTS

THEY'RE HERE! **FERRAMIC® "Q"**

THREADED PERM-TUNING CORES

(SHOWN TWICE ACTUAL SIZE)

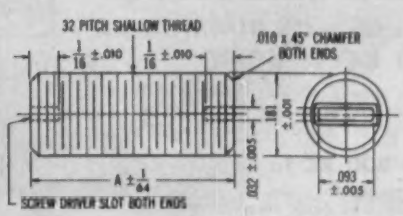
EE-F606-2



PART. NO.	DIMENSION A
F606-1	.250
EE-F606-2	.375

(SHOWN TWICE ACTUAL SIZE)

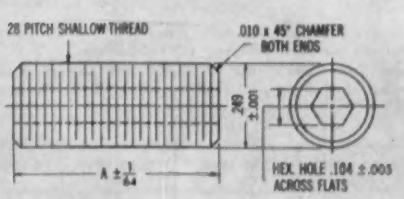
EE-F607-1



PART. NO.	DIMENSION A
EE-F607-1	.312
F607-2	.375

(SHOWN TWICE ACTUAL SIZE)

EE-F608-1



PART. NO.	DIMENSION A
EE-F608-1	.375

...Economy–engineered by GENERAL CERAMICS to M. P. A. Standard 11-53T

Following two years of intensive research and development by General Ceramics specialists, three standard threaded perm-tuning cores are now available from stock. These standard cores are offered in several lengths to meet industry's diversified requirements. Call, wire or write for quotations, today!

MAGNETIC PROPERTIES

PROPERTIES	UNIT	"Q"
Initial Perm. at 1 mc/sec.	—	125
*Max. Perm.	—	400
*Sat. Flux Density	Gauss	3300
*Residual Mag.	Gauss	1800
*Coercive Force	Oersted	2.1
Temp. Coef. of Initial Perm.	%/°C	.10 max.
Curie Point	+°C	350
Vol. Resistivity	ohm-cm.	High
Loss Factor:	$\frac{1}{\omega_0 Q}$	
At 1 mcs/sec.	—	.000020
At 5 mcs/sec.	—	.000050

*Measurements made on D.C. Ballistic Galvanometer with Hmax = 25 oersteds. Above data is based on nominal values.

GENERAL CERAMIC CORPORATION — STEATITE INSULATORS

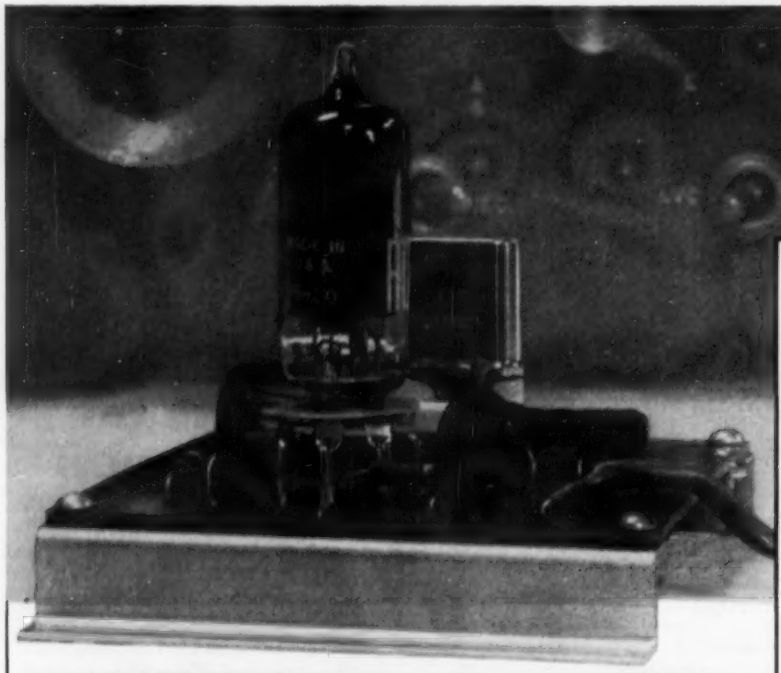
General CERAMICS CORPORATION

TELEPHONE: VALLEY 6-5100

GENERAL OFFICES and PLANT: KEASBEY, NEW JERSEY

MAKERS OF STEATITE, ALUMINA, ZIRCON, PORCELAIN, SOLDERSEAL TERMINALS, "ADVAC" HIGH TEMPERATURE SEALS, CHEMICAL STONEWARE, IMPERVIOUS GRAPHITE, FERRAMIC MAGNETIC CORES

Want more information? Use post card on last page.



OSCILLATOR SPECIFICATIONS

	FO-1 (fundamental)	FO-1B (overtone)
Freq. Range	200 KC-15,000 KC	15 MC-60 MC (in 4 ranges)
RF Output	3 to 10 volts into 1200 ohms	2 to 7 volts into 1200 ohms
Plate Power	210 volts @ 5 ma	210 volts @ 5 ma
Heater Power	6.3 volts @ 150 ma	6.3 volts @ 150 ma
Tube	6BH6	6AK5
Maximum Drift with ± 20% Plate Voltage change—	.0002%	.0002%
Maximum Drift 40°F to 120°F— ±.002% incl. crystal* (*except 200 to 500 KC ± .02%)		
Calibration Tolerance	.001% to .01%	.001% to .01% depending on FX-1 crystal used
Size	4"x4"x3" overall	4"x4"x3" overall
Mounting	4 holes (with brackets provided)	

PRINTED CIRCUIT OSCILLATORS

for Generating Spot Frequencies with GUARANTEED Tolerance from 200 KC to 60MC

Since the operating tolerance of a crystal is greatly affected by the associated operating circuit, the use of the FO-1 Oscillator in conjunction with the FX-1 Crystal will guarantee close tolerance operation. Tolerances as close as .001 percent can be obtained.

FO-1 for Fundamental Operation 200 KC to 15,000 KC

FO-1—Oscillator Kit (less tube and crystal) $3.95
FO-1A—Oscillator, factory wired & tested with tube (less crystal) ... $6.95

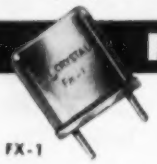
FO-1B for Overtone Operation 15 MC to 60 MC

FO-1B—Oscillator Kit (less tube and crystal) $3.95*
FO-1BA—Oscillator, factory wired & tested with tube (less crystal) $6.95*

*Includes coil in one of four ranges: 15-20 MC, 21-30 MC, 31-40 MC, or 41-60 MC, specify when ordering. Extra coils 35c each.

FO-1 Kit

FX-1 CRYSTAL Companion to the FO-1 Series Oscillator



FX-1

The FX-1 Crystal is designed for use only with the FO-1 Oscillater. For tolerances of .01% and .005% any FX-1 Crystal can be used with any FO-1 Oscillator.

For tolerances closer than .005% the Oscillator and Crystal must be purchased together. The Oscillator is factory wired, and the crystal custom calibrated for the specific oscillator.

For crystal prices consult table below:

TOLERANCE	200-499 KC	500-999 KC	1000-1499 KC	1500-1999 KC	2000-9999 KC	10,000-15,000 KC	15 MC-29.9 MC	30 MC-60MC
.01%	$ 8.75	$12.50	$ 5.25	$ 3.75	$ 2.50	$ 3.25	$ 3.00	$ 4.00
.005%	$12.50	$15.00	$ 6.00	$ 4.50	$ 3.00	$ 4.00	$ 5.00	$ 6.50
(.0025% and .001% tolerances are available only by purchasing the FO-1 Oscillator and Crystal together)								
.0025%	$17.50*	$17.50*	$ 6.75*	$ 5.25*	$ 3.75*	$ 4.75*	$ 6.50*	$ 8.50*
.001%	$25.00*	$25.00*	$ 8.00*	$ 6.50*	$ 5.00*	$ 6.00*	$10.00*	$15.00*

*Prices are for crystal only. To insure tolerances closer than .005% crystal must be purchased with oscillator factory wired and tested. For total price add $6.95 to price of crystal desired.

HOW TO ORDER: In order to give the fastest possible service, crystals and oscillators are sold direct. Where cash accompanies the order, International will prepay the postage; otherwise, shipment will be made C. O. D.

International CRYSTAL Mfg. Co., Inc. 18 N. Lee Phone FO 5-1165 OKLAHOMA CITY, OKLA.

Fast, local field servicing for -hp- instruments

HEWLETT-PACKARD instruments are built to be trouble free. But when repair, calibration, parts replacement or routine maintenance *is* required, the work can be done quickly and correctly by service engineers in principal cities across the U. S. These men are factory trained and periodically re-trained. They have complete repair and test facilities—in many cases the equal of those at the *-hp-* plant. They are constantly provided with the latest in service and maintenance techniques.

When you need good, fast service on *-hp-* instruments, call your *-hp-* representative—the authorized repair station for all *-hp-* equipment.

For expedited field service call or write:

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NEW YORK 21:
RMC Associates
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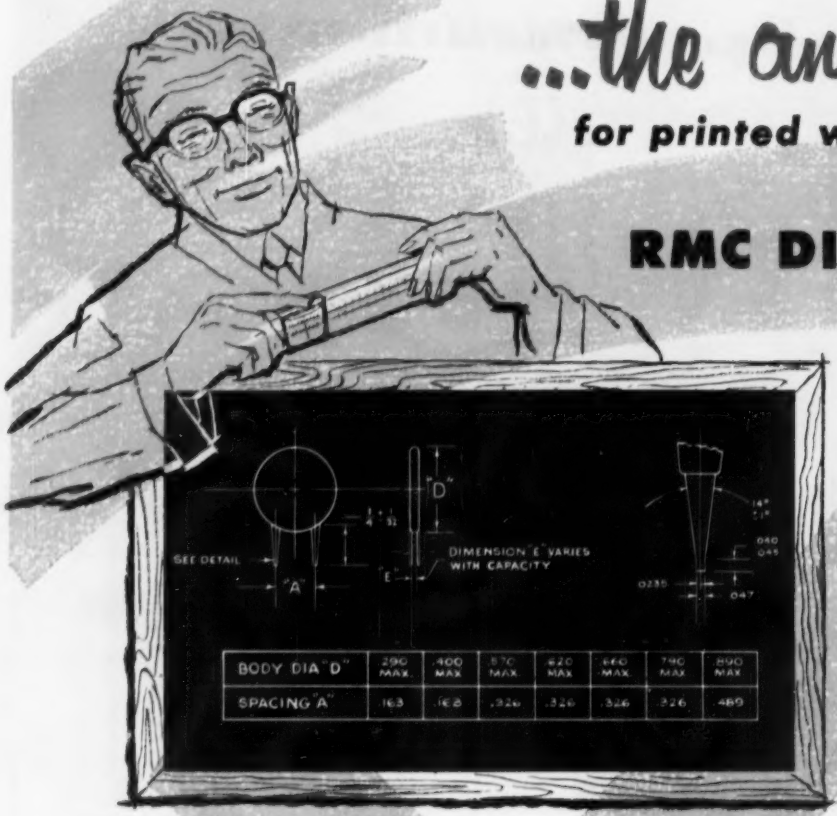
hp means complete coverage in service, too!

...the answer

for printed wire circuits

RMC DISCAPS.



Wedg-loc... The exclusive wedge leads on these DISCAPS lock securely in place on printed circuit assemblies prior to the soldering operation. There is no possibility of the capacitors becoming loose or falling out and the soldered connection is always uniform.

Available in capacities between 2 MMF and 20,000 MMF, Wedg-loc DISCAPS can be furnished in temperature compensating, by-pass, and stable capacity types. Suggested hole size is a .062 square.

Plug-in... RMC plug-in DISCAPS are designed to simplify production line problems on printed circuits. Leads are No. 20 tinned copper (.032 diameter) and are available up to 1½" in length. Plug-in DISCAPS are manufactured in temperature compensating, by-pass, and stable capacity types and include the mechanical and electrical features that have made standard DISCAPS the favorite of leading manufacturers.

Write today on your company letterhead for expert engineering help on any capacitor problem.

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS CORPORATION

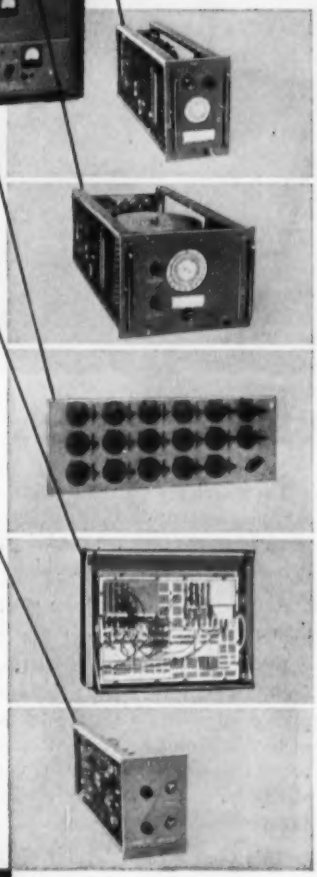
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Two RMC Plants Devoted Exclusively to Ceramic Capacitors

announcing the

New REEVES REAC HIGH SPEED 400 ANALOG COMPUTER



New BUILDING-BLOCK CONSTRUCTION

. . . an exclusive Reeves design principle that permits assembly of computer elements in any desired combination to form exactly the computer necessary to do a particular job or to expand an existing installation. REAC 400 can be assembled, component by component, to fit specific requirements at minimum cost, time, space and effort. REAC 400 is completely adaptable to the scope and complexity of your control problem, now or in the future.

New HIGH SPEED SERVOS

Servo multipliers have bandwidth over 50 cps. Velocity 1500 v/sec; acceleration 60,000 v/sec^2. Six gang pots; two tapped with front panel plug-in turrets for function generation.

New HIGH SPEED RESOLVERS

Vastly improved dynamic performance . . . *35-cycle bandwidth.* Rectangular and Polar operation; Full AGC either mode. Front panel plug-in turrets for easy padding for function generation.

New PROBLEM CHECK

New Reeves development permits verification of problem solution directly from equations before problem is run.

Checks:
- Operation of all components used
- Patching of problem from diagram
- Diagramming of problem from equations

New CONVENIENT PATCHBAY

Available in units of 1632, 3264 or 4891 holes for maximum flexibility. Color-coded mask aids in patching. Patchboard changes possible during operation.

New POWERFUL AMPLIFIERS

New dual amplifier chassis, individually chopper-stabilized. Noise less than 3 *mv rms in cabinet.* Phase shift 0.025° @ 100 cps. Bandwidth 10KC under cabinet conditions.

Reeves INSTRUMENT CORPORATION

REEVES INSTRUMENT CORPORATION

A Subsidiary of Dynamics Corporation of America

201 East 91st St., New York 28, N. Y.

REAC Analog Computers

Precision Floated GYROS

Precision RESOLVERS and PHASE SHIFTERS

SERVO MECHANICAL PARTS

IRVES

CAUGHT!—by Silent Sounds

Suddenly, the lights snap on. Someone yells—

"Don't move or we shoot!"

How had the burglar been detected? No one saw him enter. No sign of an alarm system.

No obvious sign, that is. But there *was* an Alertronic Burglar Alarm.

This unusual protective device operates by sending out 19,200 cycle-a-second sound waves, too high for human ears to hear. The slightest movement of an intruder disturbs these waves and activates the alarm.

What produces the vibrations? Two slender nickel rods—and a principle of physics called magnetostriction (the peculiar way nickel changes length in a changing magnetic field).

Putting magnetostriction to work in this ultrasonic burglar alarm wasn't an overnight job. The inventor made his first experiments twelve years ago.

The search for a material with necessary magnetostrictive properties ended when he came to Inco. Nickel proved to be the material he was seeking.

And, as it turned out, he got more than a metal from Inco . . .

In the years that have passed, he has found Inco always ready to help in supplying information on the properties of Inco Nickel Alloys and other metals . . . on the technical aspects of magnetostriction . . . and on questions involving metal fabrication.

This same type of friendly cooperation, of course, is yours for the asking. Let's get together on your problem.

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

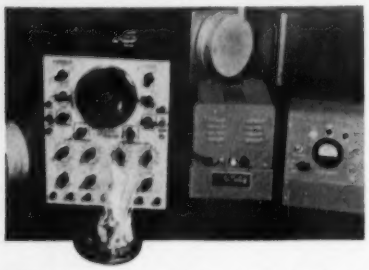
Inco Nickel Alloys

INCO TRADE MARK

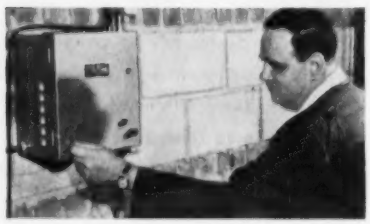
NICKEL ITEMS

Who can guess what new use of magnetostriction will be announced next? Nickel transducers from little rods the size of match sticks up to ton-size blocks are already being used for killing germs by silent sounds, to measure ocean depths, to locate fish, for dust precipitation, for faster drilling of wells, for shaping gems and cutting tool materials so hard they normally have to be cut laboriously with diamonds.

When installed according to specifications of insurance underwriters and connected to central protective system, Alertronic enables users to qualify for 60% reduction in insurance premiums.



Even the motion of heated air from burning wad of paper in ash tray sets off Alertronic alarm as pictured by jumping lines of the oscillograph tube in this demonstration set-up.



Inventor Samuel Bagno, Vice President of The Ultrasonic Division of Walter Kidde & Co., Inc., flips a switch as he leaves his own plant to connect the alarm unit into Central Patrol Office.

If you really want more facts and technical data on the magnetostrictive properties of nickel, ask for our bulletin "Magnetostriction." It is written for engineers and physicists.

MONEL® • "R"® MONEL • "K"® MONEL "KR"® MONEL • "S"® MONEL • INCONEL® INCONEL "X"® • INCONEL "W"® INCOLOY® • NIMONIC® ALLOYS • NICKEL LOW CARBON NICKEL • DURANICKEL®

Want more information? Use post card on last page.

ON TIME
ON TIME
MEMO
From: Engineering & Production
To: Sales Department
Subject: Size 8 and 22 Synchros
As promised last November, our size 8 and 22 standard synchros are now in production and available for 3 weeks or less delivery.
In addition, we have added the BuOrd type size 15 transmitter to the line.
Next
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1.437" diameter
ACTUAL SIZE
RESOLVER
cppc
Size 11
1.062" diameter
ACTUAL SIZE
Size 10
.937" diameter
ACTUAL SIZE
BuOrd Size 15
1.437" diameter
ACTUAL SIZE
BONUS
TRANSMITTER
TYPE CG-22-A-11
cppc
PRECISION PRODUCTS
HERE!
Size 22
2.161" diameter
ACTUAL SIZE
Next
HERE!
Size 8
.750" diameter
ACTUAL SIZE
Look to cppc for Synchro Progress
cppc
CLIFTON PRECISION PRODUCTS CO., INC.
CLIFTON HEIGHTS
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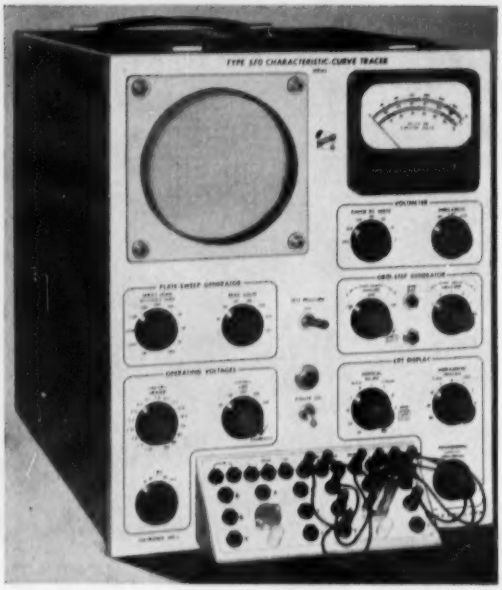
Save Time in Circuit Design

Get advance information... in graphic form... on vacuum-tube behavior in new circuitry—

with the Type 570 Characteristic-Curve Tracer



The Tektronix Type 570 Characteristic-Curve Tracer can save you many hours in circuit-development work by providing quick, accurate pictures of vacuum-tube characteristics. You have complete control of the operating-condition setup, permitting a realistic approach to actual circuit conditions, whatever they may be. You get curves that can be very important in a particular circuit problem; but are rarely, if ever, published in handbooks.

The Type 570 can also be used for rapid preselection of vacuum tubes, either by comparison with another vacuum tube, or with curves outlined on a crt mask.

Please call your Tektronix Field Engineer or Representative or write direct for new booklet, Type 570 Technical Description.

Displays Families of Curves on CRT Screen

Choice of four to twelve characteristic curves per family—with as many as 8 positive-bias curves per family.

Plots All Important Characteristics

Plate current against plate voltage.
Plate current against grid voltage.
Screen current against plate voltage.
Screen current against grid voltage.
Grid current against plate voltage.
Grid current against grid voltage.

Calibrated Controls

Accurate current and voltage readings directly from the crt screen.

Wide Display Range

11 current ranges from 0.02 ma/div to 50 ma/div.

9 voltage ranges from 0.1 v/div to 50 v/div.

11 series-load resistors from 300 ohms to 1 megohm.

7 grid-step values from 0.1 v/step to 10 v/step.

Price — $925

f.o.b. Portland (Beaverton), Oregon

Fig. 1 — *Plate current plotted against plate voltage for one triode section of a 12AU7. Plate load is 5 k, peak plate-supply voltage is 500 v. Grid voltage is changed 5 v between curves, from —35 v. to zero. Vertical sensitivity is 5 ma/div, horizontal sensitivity 50 v/div. Calibrated controls permit accurate current and voltage readings directly from the screen.*

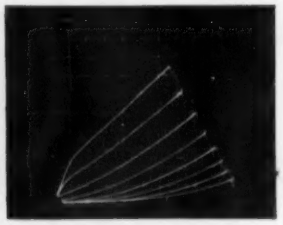


Fig. 2 — *Same triode section of 12AU7 with only 20-v peak plate supply and sensitivities increased to 0.2 ma/div vertical and 2 v/div horizontal. Grid voltage is changed 2 v between curves, from —14 v to zero. This is essentially a 25-times magnification of the lower left portion of Fig. 1, showing the operating characteristics at low plate-supply voltage.*

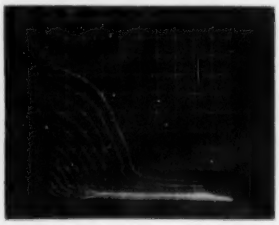


Fig. 3 — *Screen current plotted against plate voltage with positive grid bias on a 6AQ5. Plate load is 300 ohms, peak plate voltage is 100 v, screen-grid voltage is 100 v, with grid voltage changing 2 v/step from +16 v to below zero. Vertical scale is 10 ma/div, horizontal scale 10 v/div.*

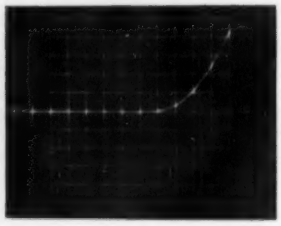


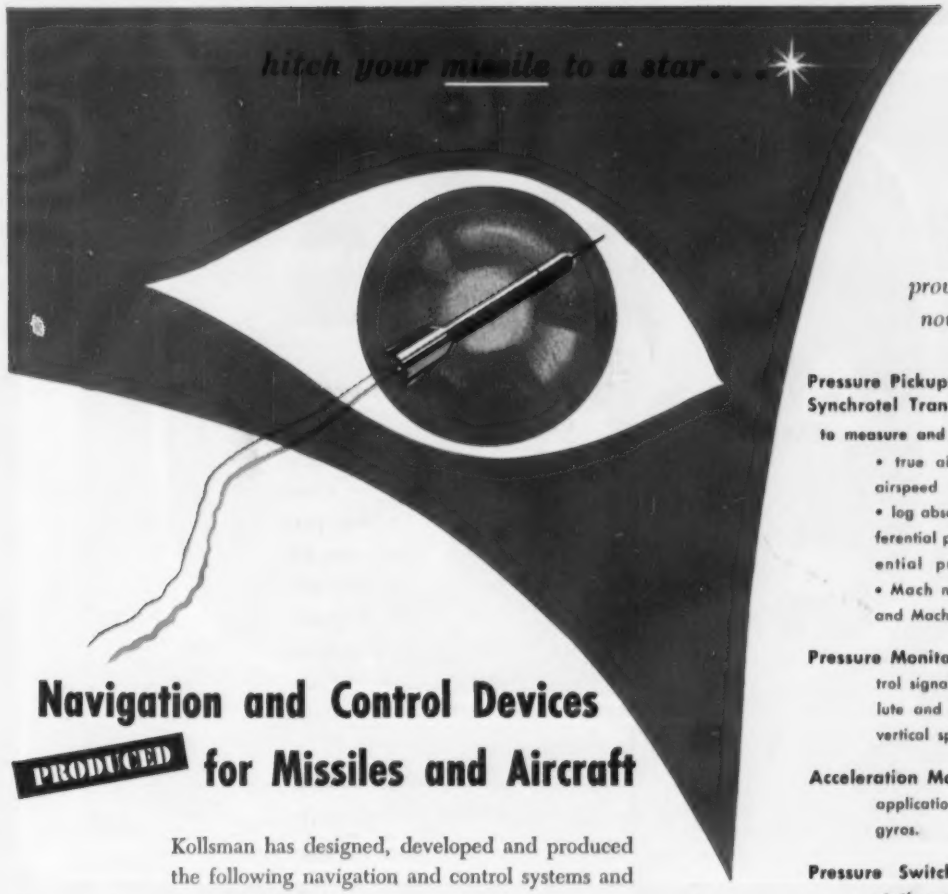
Fig. 4 — *Typical Germanium Diode curve. Inherent flexibility of the Type 570 permits accurate evaluation of diode characteristics and detailed examination of any part of the curve. Calibrated scales above are 0.2 v/div horizontal, 0.5 ma/div vertical, with zero points at center of screen.*

See and try the Type 570 at the National Electronic Conference in Chicago, Booths 133 and 134.

Tektronix, Inc.

P. O. Box 831, Portland 7, Oregon

CYpress 2-2611 **Cable: TEKTRONIX**



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Kollsman has designed, developed and produced the following navigation and control systems and components:

FOR NAVIGATION OR GUIDANCE

CLASSIFIED **Photoelectric Sextants** for remote semi-automatic celestial navigation.

CLASSIFIED **Automatic Astrocompasses** for precise automatic celestial directional reference and navigation.

Photoelectric Tracking Systems For many years Kollsman has specialized in high precision tracking systems.

Periscopic Sextants for manual celestial observations.

CLASSIFIED **Computing Systems** to provide precise data for automatic navigation and guidance, operated by optical, electromechanical, and pressure sensing components.

FOR CONTROL

proven components now in production

Pressure Pickups and Synchrotel Transmitters

to measure and electrically transmit • true airspeed • indicated airspeed • absolute pressure • log absolute pressure • differential pressure • log differential pressure • altitude • Mach number • airspeed and Mach number.

Pressure Monitors — to provide control signals for altitude, absolute and differential pressure, vertical speed, etc.

Acceleration Monitors — for many applications now served by gyros.

Pressure Switches — actuated by static pressure, differential pressure, rate of change of static pressure, rate of climb or descent, etc.

Motors — miniature, special purpose, including new designs with integral gear heads.

SPECIAL TEST EQUIPMENT

optical and electromechanical for flight test observations.

Please write us concerning your specific requirements in the field of missile or aircraft control and guidance. Technical bulletins are available on most of the devices mentioned.

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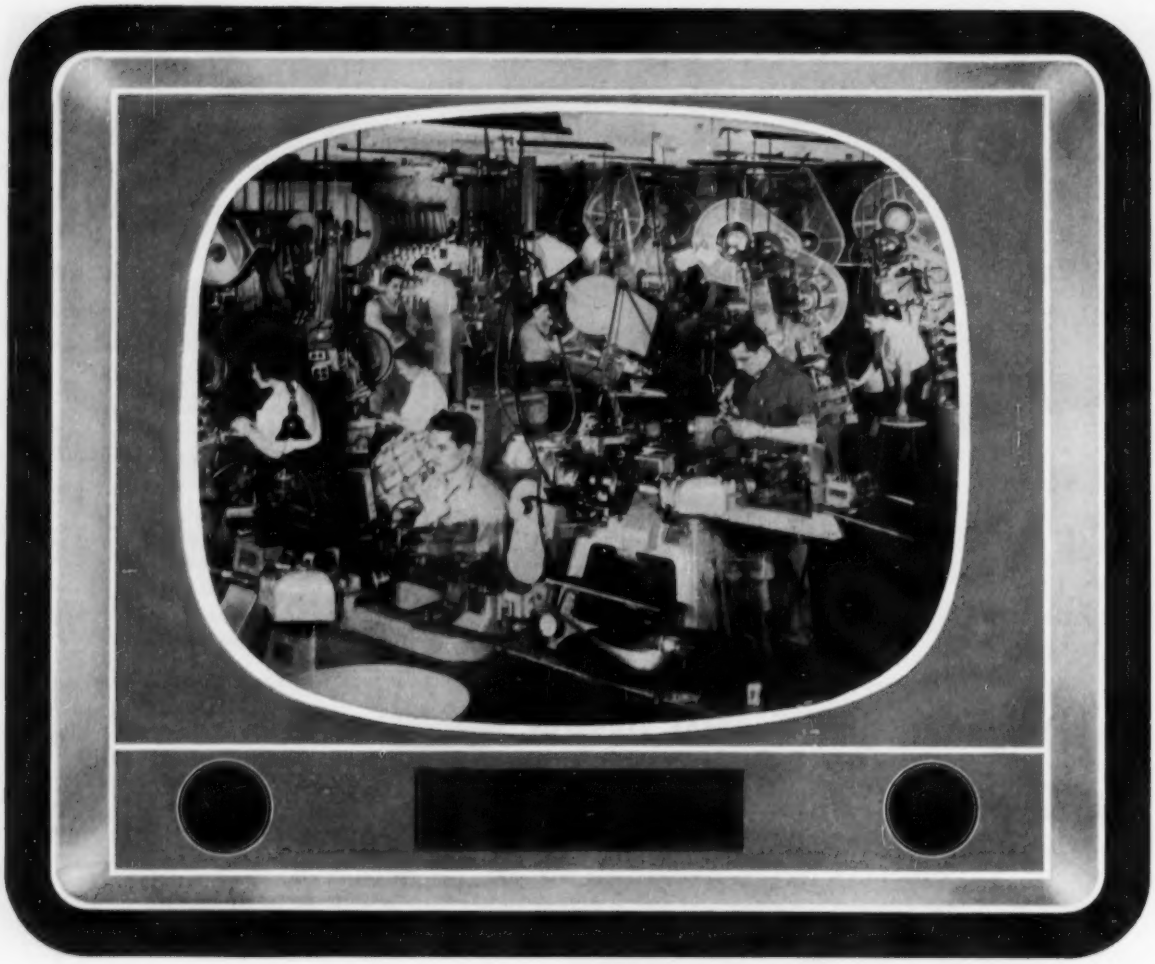


Picture of Your Set Being Improved by Volkert Stampings Production

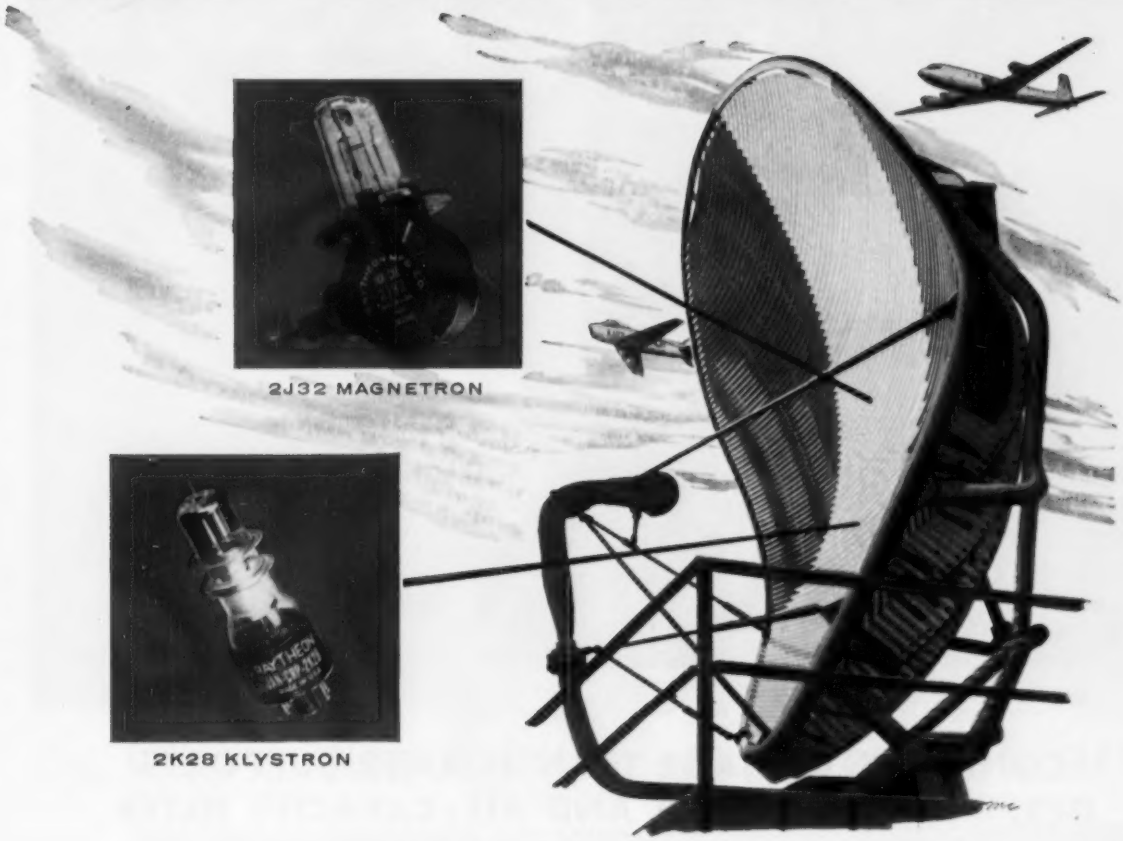
We would really need a "wide-screen" TV set to show the many rows of power presses, eyelet machines and four-slide machines that enable Volkert to meet all your precision stamping needs...but this picture gives you some indication of the modern, fully-automatic equipment that we use in turning out more than ten million accurate stampings a week for leading tube and set manufacturers.

And these unsurpassed production facilities are only a *part* of Volkert's complete service to design, tool and produce precision electronic stampings to *your* specifications.

If you want the complete picture of electronic stampings, here are two suggestions: Ask for *The Volkert View* quarterly; let us show our color film, *Stampings for Electronics,* in your plant.

VOLKERT STAMPINGS, INC.
222-34 96th Avenue, Queens Village 29, L. I., N. Y.
for design...tooling...and production of precision stampings

Volkert



2J32 MAGNETRON

2K28 KLYSTRON

HELPING ESTABLISH RELIABILITY RECORDS

Raytheon Magnetrons and Klystrons in proved Gilfillan ASR-1 Radar

Civil Aeronautics Administration reports record-breaking reliability of Gilfillan airport surveillance radar. Boston International Airport had 8,760 hours continuous performance with only 7⅓ hours involuntary outage—less than 1/10 of 1%—from their Gilfillan installation.

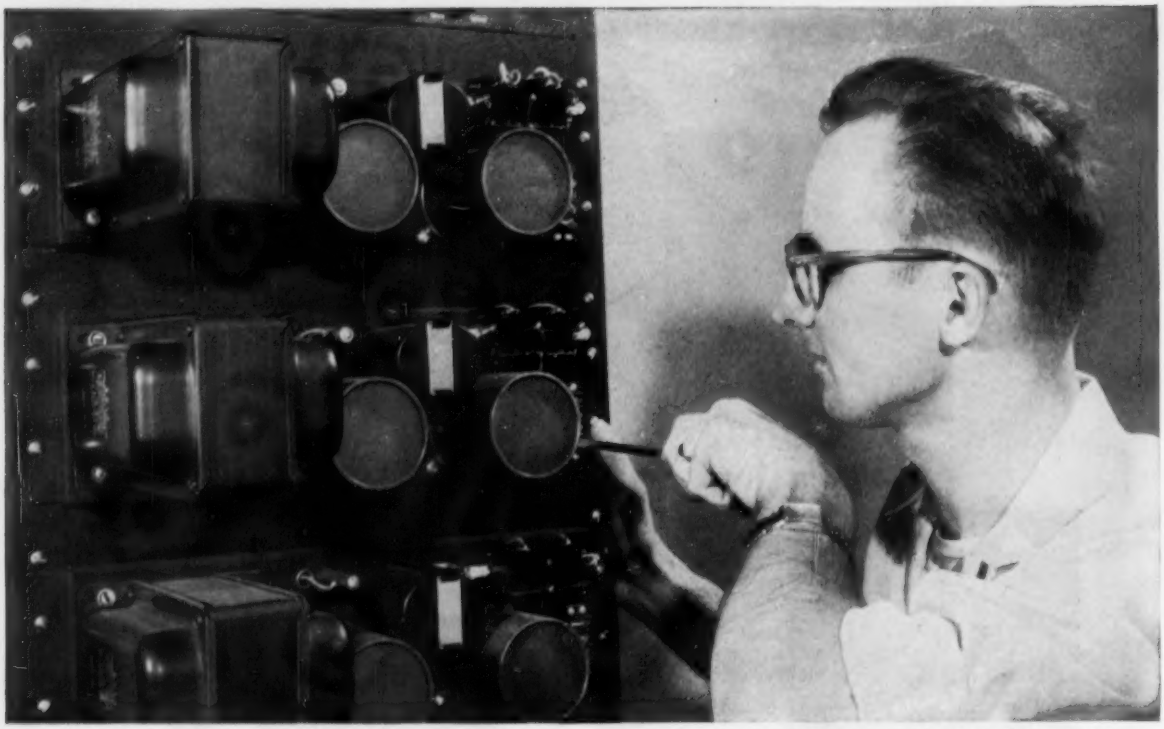
Condensed Typical Operating Data							
	Power Output	Frequency Range, mc	Reflector Voltage	Resonator Voltage	Maximum Temp. Coef.	Tuning	Cavity
2K28	140 mw	1200-3750	−140 v. to −300 v.	300 v.	±.15	Mech. Inductive	Ext.
	Power Output	Frequency Range, mc	Anode kv	Anode Amps.	Pulse Width	P.R.R.	
2J32	285 kw min.	2780-2820 Fixed freq.	20	30	1 μsec	1,000	

Check these performance records of Raytheon tubes in the Gilfillan ASR-1. Average life, 2J32 Magnetron: 4,000 hours. Average life, 2K28 Klystron: 2,500 hours.

Your microwave and radar equipment offers extra reliability when you specify Raytheon Magnetrons and Klystrons. Use these rugged, reliable tubes in your present and proposed systems. Contact Power Tube Sales to take advantage of Raytheon's Application Engineer Service, without obligation. Write for free Tube Data Booklets.

RAYTHEON *Excellence in Electronics*

RAYTHEON MANUFACTURING COMPANY, Microwave and Power Tube Operations, Section PL25, Waltham 54, Massachusetts



The photograph above shows three typical Sola Constant Voltage DC Power Supplies being mounted on a relay rack. Each chassis is completely assembled by Sola Electric Co. and supplied as a single unit.

CONSTANT VOLTAGE TRANSFORMER SUPPORTS GERMANIUM RECTIFIER AND ALL-CAPACITY FILTER IN MEETING A *TOUGH* DC POWER PROBLEM

This unique dc power supply assembly uses three unusual components:

- A CONSTANT VOLTAGE transformer
- A germanium rectifier
- A high-capacitance filter (no choke).

They mutually support and protect each other in providing high output voltage stability in the face of varying or heavy "pulse" loads.

Result: — They are being adopted by manufacturers of computers, tabulating machines, and others who *must have reliable operation* of relays, solenoids, etc., in spite of severe line voltage and load fluctuations. Specifically, these special assemblies provide:

1. ±1% or less output voltage change with ±15% line voltage variations.
2. Minimum output voltage change with wide, rapid load changes.
3. High, short-time overload capacity without damage to components.
4. Ripple approximately 1%.
5. High overall economy by eliminating overload capacity needed with other types of power packs for this duty.
6. Simplicity, compactness, and light weight as compared with equipment employing saturable cores, heavy chokes, tubes, revolving or other movable parts.

Sola is now designing and assembling complete dc power supply assemblies in the general ranges of up to 50 volts at 25 amperes; or up to 400 volts at 0.4 amperes. Series and parallel operation have proved quite feasible for serving higher demands. While featuring the special capabilities of voltage-regulating transformers, germanium rectifiers, and high-capacitance filter as a "team"; Sola invites inquiries on assemblies of any type of transformer, rectifier, and filter, or separate voltage-regulating transformers designed to feed existing rectifier-filter combinations. Write for descriptive folder, or contact your nearest district sales engineer.

SOLA *Constant Voltage* **TRANSFORMERS**

CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • **LIGHTING TRANSFORMERS** for All Types of Fluorescent and Mercury Vapor Lamps. • **SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414** • *NEW YORK 35: 103 E. 125th St., TRafalgar 6-6464* • *PHILADELPHIA: Commercial Trust Bldg., Rittenhouse 6-4988* • *BOSTON: 272 Centre Street, Newton 58, Mass., Bigelow 4-3354* • *CLEVELAND 15: 1836 Euclid Ave., PRospect 1-6400* • *KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4382* • *LOS ANGELES 23: 3138 E. Olympic Blvd., ANgelus 9-9431* • *TORONTO 9, ONTARIO: 617 Runnymede Rd., Lyndhurst 1654* • *Representatives in Other Principal Cities*

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A new dead reckoning navigational computer — AUTOMATICALLY indicating ground position — derived from airspeed, heading and wind.

TOTAL SYSTEM WEIGHT — 18 LBS.

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LORAL ELECTRONICS CORPORATION

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AN OUTSTANDING PYE PAIR

60-WATT H.F. FIXED STATION

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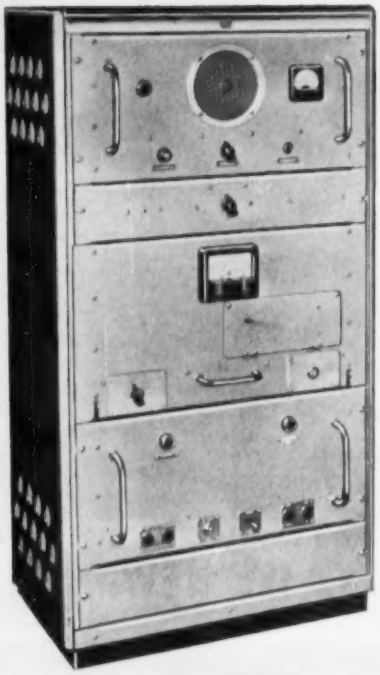

50-WATT V.H.F. FIXED STATION

60—184 Mc/s

Employing the latest techniques this most efficient station is of particular value for fixed and mobile V.H.F. schemes, ground-to-air control of aircraft and point-to-point links. Six-channel operation is available if required.

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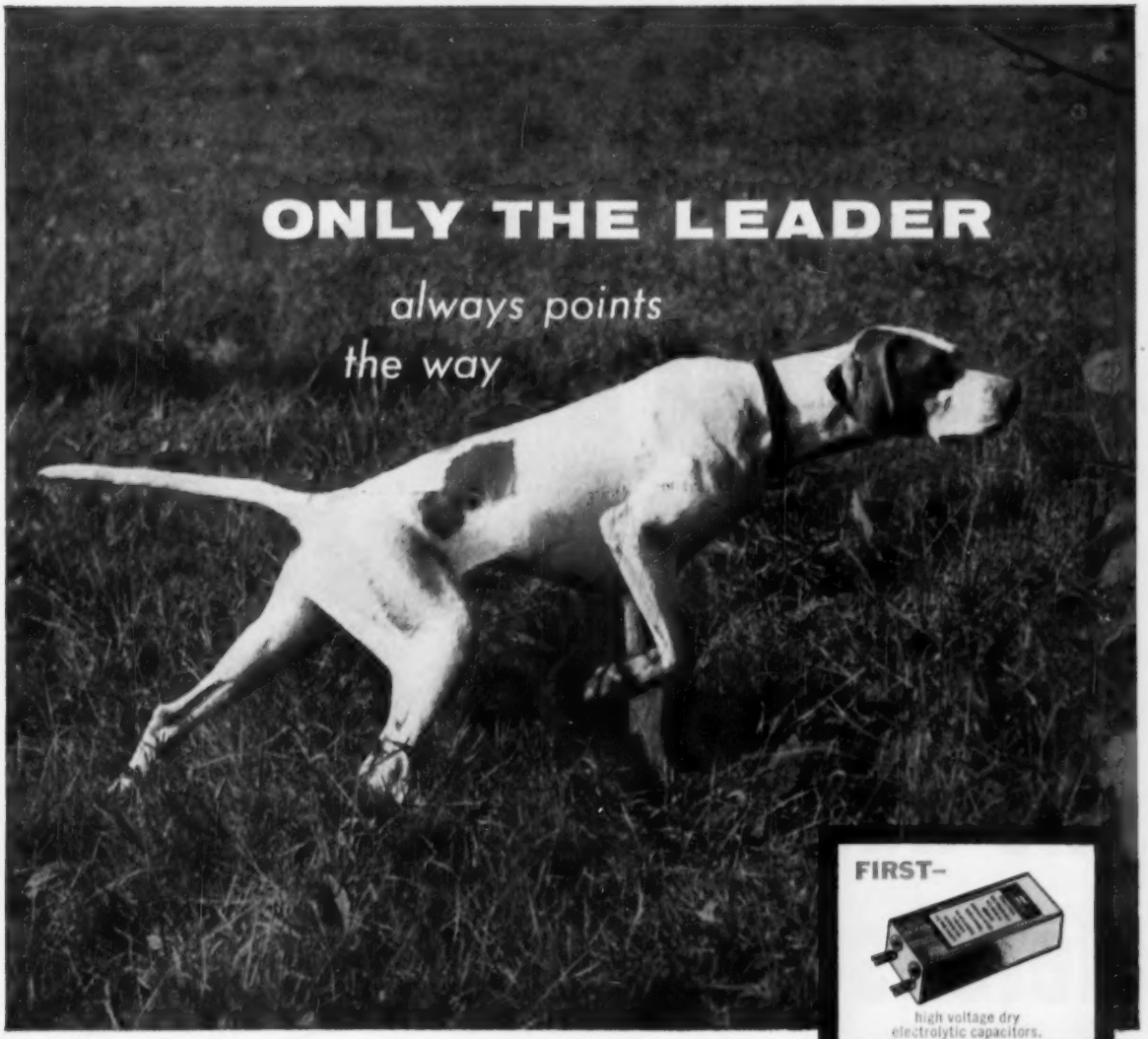

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high voltage dry electrolytic capacitors.

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FIRST–

capacitor to use anodic aluminum foil electro-chemically etched.

C·D...45 YEARS OF famous FIRSTS

Typical of these "famous firsts" are the three examples shown here . . . *proof* that whatever your capacitor requirements may be, your needs can be filled by C-D. Write to Cornell-Dubilier Electric Corp., Dept. K-95, South Plainfield, N. J.

FIRST–

miniature, metal-cased electrolytic capacitors.

CONSISTENTLY DEPENDABLE

CORNELL-DUBILIER CAPACITORS

PLANTS IN SO. PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER AND CAMBRIDGE, MASS.; PROVIDENCE AND HOPE VALLEY, R. I.; INDIANAPOLIS, IND.; SANFORD AND FUQUAY SPRINGS, N. C.; SUBSIDIARY, RADIART CORP., CLEVELAND, OHIO.

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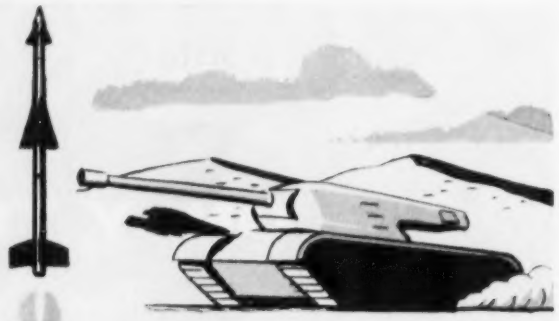
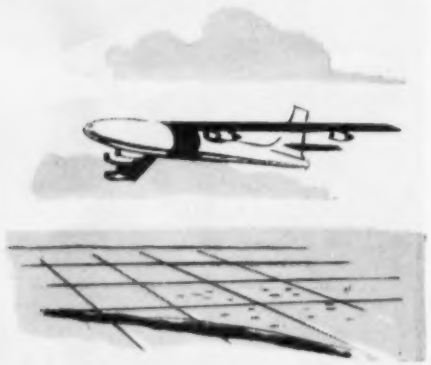
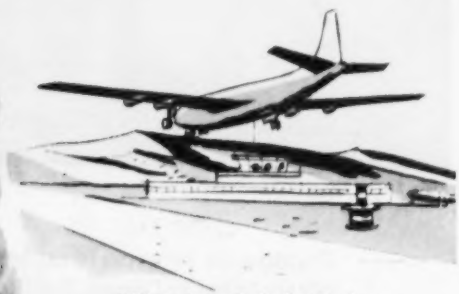
Wincharger dynamotors help power the nation's defense



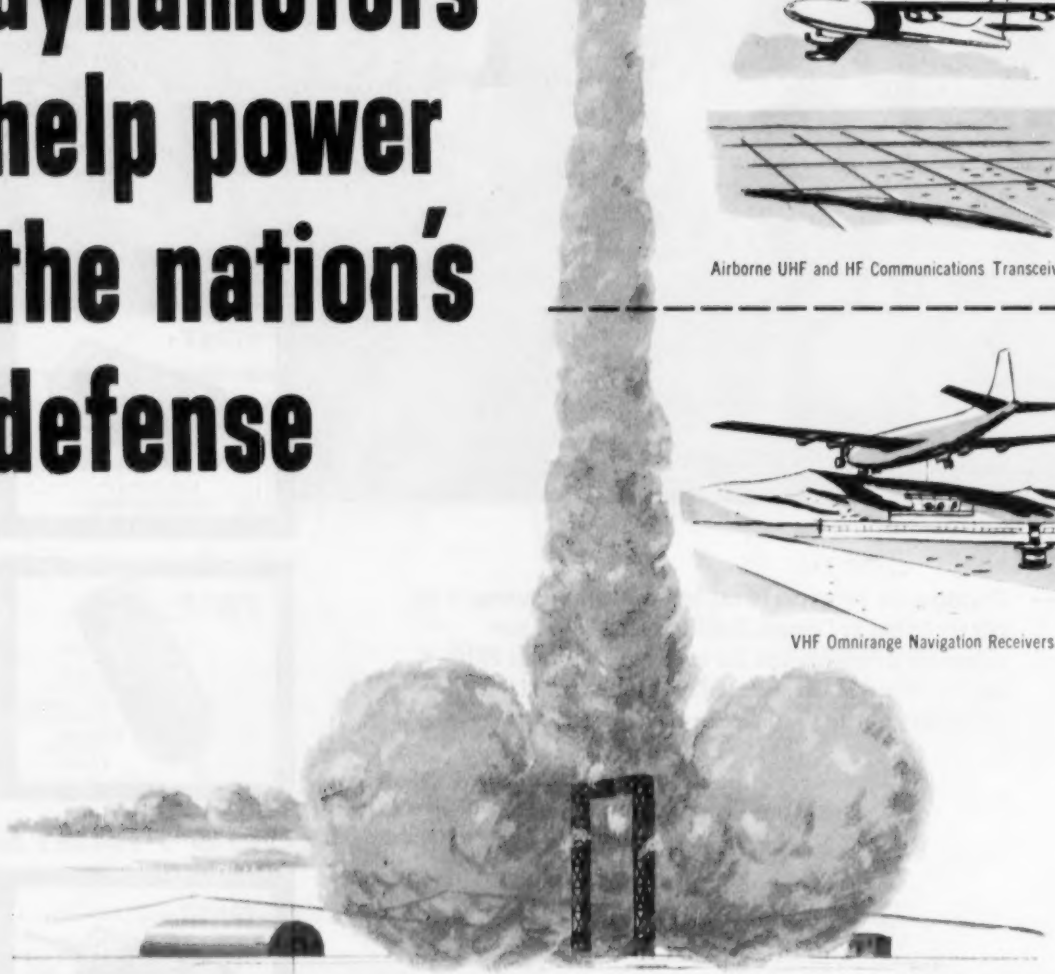
Vehicular HF Communication Transmitters



Airborne UHF and HF Communications Transceivers



VHF Omnirange Navigation Receivers



Guided Missile Development

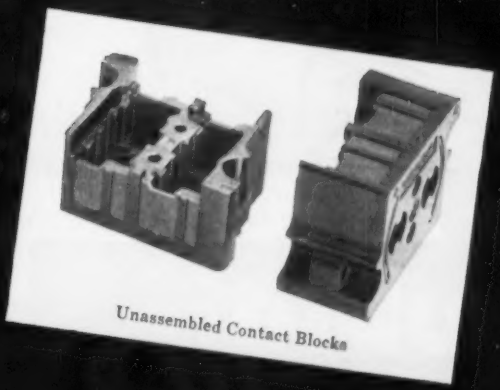
WINCHARGER CORPORATION

Sioux City 2, Iowa

A wholly owned subsidiary of Zenith Radio Corporation

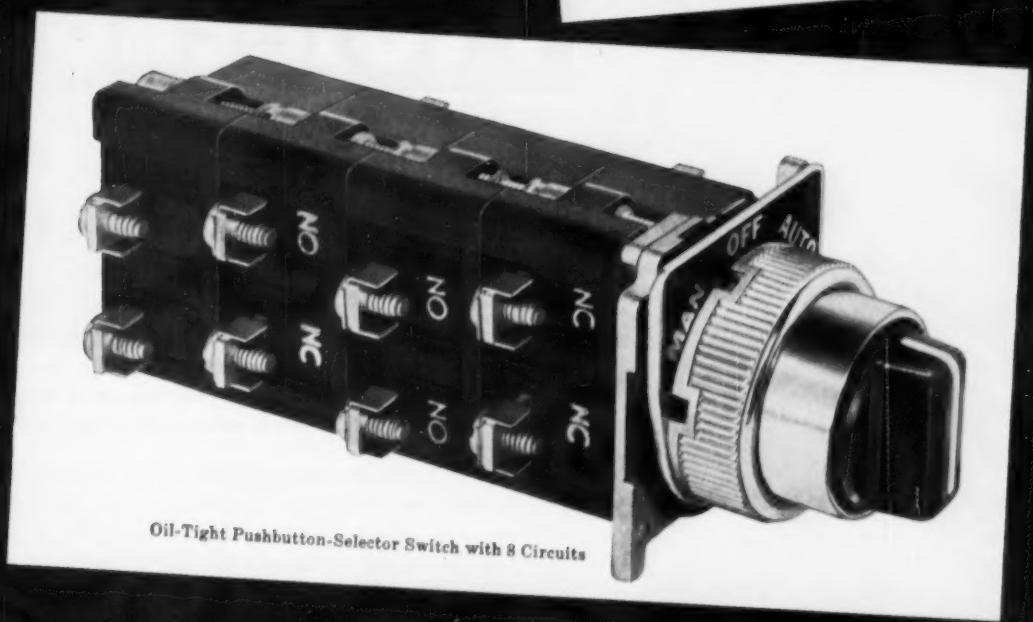
Engine Generators • Universal Motors • Dynamotors
Inverters • Wind Driven Generators

Cutler-Hammer selects **RESINOX* 3700** to mold contact blocks for new selector switches



Unassembled Contact Blocks

Oil-Tight Pushbutton Contact Block



Oil-Tight Pushbutton-Selector Switch with 8 Circuits

MONSANTO'S THERMOSETTING MOLDING MATERIAL COMBINES IMPROVED ELECTRICAL PROPERTIES WITH NON-CRITICAL MOLDABILITY

Mark up another job where outstanding results have been achieved with Resinox 3700 ! The contact blocks for Cutler-Hammer's new line of heavy-duty oil-tight pushbutton switches are molded of this mineral-filled Monsanto material. Resinox 3700 was chosen for this specialized application because of its excellent electrical properties and short-cure cycles. Other characteristics of Resinox 3700 which are improving the profit picture for manufacturers of electrical parts include high arc resistance, dielectric strength, dimensional stability, heat resistance and durability. Perhaps Resinox 3700 is exactly what *you* need to solve an electrical parts problem. Write today for full information. Monsanto Chemical Company, Plastics Division, Dept. E9, Springfield 2, Mass.

MONSANTO

For outstanding electrical properties, specify **RESINOX 3700**

*RESINOX, REG. U. S. PAT. OFF.

Buss Fuses give you..

Double Protection

. . Against loss of Customer Satisfaction

To make sure of proper operation under all service conditions — every BUSS fuse normally used by the Electronic Industries is tested in a sensitive electronic device. Any fuse not correctly calibrated, properly constructed and right in all physical dimensions is automatically rejected.

That's why BUSS fuses won't blow when trouble doesn't exist. Useless shutdowns caused by poor quality fuses blowing needlessly are not only irritating to customers — but customers' confidence in your product or service could be jolted.

However, when there is an electrical fault BUSS fuses open to prevent further damage to equipment — saving users the expense of replacing needlessly damaged parts.

When you standardize on BUSS fuses, you are doubly safe.

MAKERS OF A COMPLETE LINE OF FUSES FOR HOME, FARM, COMMERCIAL, ELECTRONIC, AUTOMOTIVE AND INDUSTRIAL USE.

SAVE ENGINEERING TIME ON ELECTRICAL PROTECTION PROBLEMS

The BUSS fuse research laboratory and its staff of engineers are at your service to help you with problems involving electrical protection. Submit description or sketch and tell us your requirements.

Whenever possible, the fuse or fuse mounting selected will be available in local wholesalers' stocks, so that your device can easily be serviced.

Be sure to get the latest information on BUSS and FUSETRON small dimension fuses and fuseholders . . . Write for bulletin SFB.

ELRC 955

BUSSMANN MFG. CO. FUSETRON BUSS Div. McGraw Electric Co.

University at Jefferson St. Louis 7, Mo.

A directly calibrated generator of continuous wave or pulse modulated radio frequency signals, government model TS-419 U.

Modulation - (a) by external or internal pulse generator.
(b) by synchronization to an external pulse or sine wave generator

Frequency Range - 900 to 2100 MC/S, one band, ± 1%.

Power Output - calibrated 0 to -120 dbm

TS-419/U

SIGNAL GENERATOR NE-12-20-SG

Attenuation - uncalibrated. Variable 3 to 70 db

Sensitivity to CW - Spectrum Amplified Pos. -- 80 db. below 1 watt for 1 inch deflection.

- Spectrum Position -- 55 db. below 1 watt for 1 inch deflection.

Maximum dispersion of spectra - 1.5 MC/S per inch

TS-148/UP

The government model TS-148/UP Spectrum Analyzer:

Frequency-meter Range - 8470 to 9630 MC/S
± 5 MC/S max. error.

SPECTRUM ANALYZER NE-11-20-S

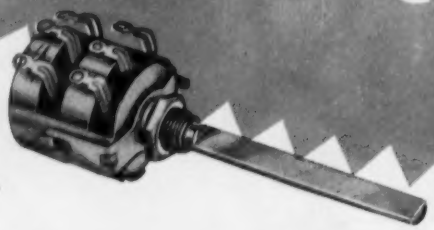
NORTHEASTERN ENGINEERING, INC.

manchester, new hampshire

STAND PAT WITH CLAROSTAT

Composition-Element CONTROLS

Series 37.



Series D37, dual with single shaft.

Series D37, dual concentric shafts with sections independently controlled.

It's better, quicker, cheaper, to specify CLAROSTAT for those carbon control requirements, because:

For **usual needs**, there's an adequate choice of standard Clarostat types such as:

SERIES 37: 1-1/8" d. 0.5 watt. Linear or tapers. One to three taps. Available with switch. Choice of shafts. Singles or duals. 500 ohm to 5 megohms. Approved for Type RV3, characteristic U, MIL-R-94 specification.

SERIES 47: 15/16" d. 0.5 watt. Linear or tapers. One tap, choice of three positions. Available with switch. Choice of shafts. Singles or duals. 500 ohms to 5 megohms.

SERIES 48: For miniaturization. 5/8" d. 0.2 watt. 500 ohms to 5 megohms, linear; or 2,500 ohms to 2.5 megohms, tapers. Singles or duals. Available with switch.

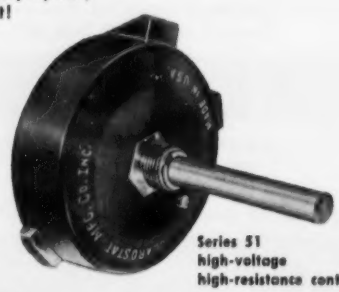
SERIES 51: For high-voltage high-resistance electronic circuitry. 1-17/32" d. phenolic case. 1 watt. 5,000 ohms to 50 megohms. 10,000 V.D.C. breakdown test between terminals and mounting bushing. Maximum operating voltage, 4,000. Tapers available.

And for **unusual needs**, Clarostat can design and put into production those special types—quickly, satisfactorily, economically — often based on ingenious adaptation of standard features and available tooling.

SEND FOR LITERATURE. Engineering collaboration, quotations and prompt delivery cycles, available on request!

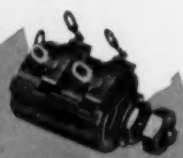
Series 47.

High-voltage couplers for use with elevated potentials.



Series 51 high-voltage high-resistance control.

Series 47S, with switch, and twist-tab mounted.



Series D48 dual control for miniaturization requirements.

CLAROSTAT

Controls and Resistors

CLAROSTAT MFG. CO. INC., DOVER, NEW HAMPSHIRE

In Canada: Canadian Marconi Co., Ltd., Toronto 17, Ont. Manufactured under license in Great Britain by A. B. Metal Products Ltd., 17 Stratton St., London W. 1, Concessionaires for British Commonwealth except Canada.

Filtered by Filtron

LOCKHEED F-94

GUARANTEES CONFORMANCE TO RADIO INTERFERENCE SPECIFICATION

MIL-I-6181B

(0.15 TO 1000 MEGACYCLES)

BOEING B-47

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FILTRON'S Engineering division, with its completely equipped screen room facilities, is always available to measure and recommend RF Interference Filters for your equipment, to meet and exceed the Radio Interference requirements of MIL-I-6181.

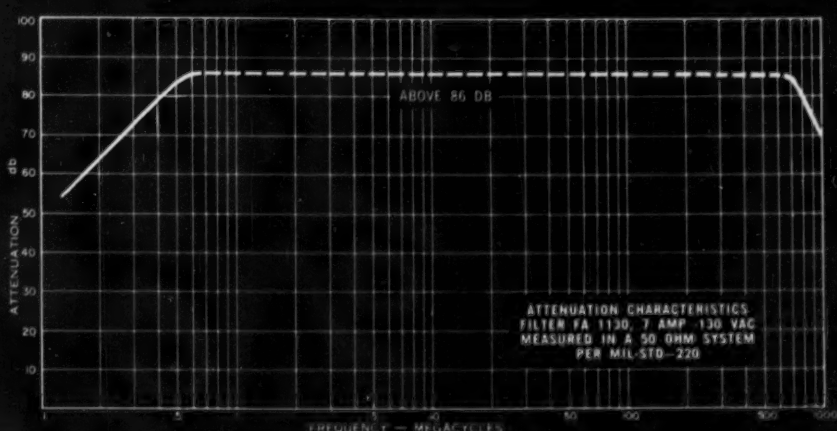
FILTRON'S production facilities are suppying more RF Interference Filters for use in military electronic equipment than ever before, to meet the nation's requirements.

FILTRON... the LEADER IN RF INTERFERENCE FILTERS... has pioneered:

- Sub-miniature Filters
- High-temperature Filters
- RF Filters to withstand Shock and Vibration
- Wide band Multi-section Units
- RF Filters "Custom Designed" to meet YOUR requirements

FILTER FA 1130
7 AMP - 130 VAC/500 VDC, 0-1700~
2" x 2" x 1¼" DEEP
BULKHEAD MOUNTED

THE 1130 SERIES IS AVAILABLE UP TO 20 AMPERES, 130 VAC/500 VDC, 0-1700~ IN STANDARD OR BULKHEAD MOUNTING, WITH SCREW OR SOLDER TYPE TERMINALS. UNITS ARE HERMETICALLY SEALED AND ARE AVAILABLE FOR 85°C OR 125°C OPERATION. THESE FILTERS HAVE MINIMUM VOLTAGE DROP, AND MEET MILITARY REQUIREMENTS.



ATTENUATION CHARACTERISTICS
FILTER FA 1130, 7 AMP 130 VAC
MEASURED IN A 50 OHM SYSTEM
PER MIL-STD-220

An inquiry on your Company letterhead will receive prompt attention

THE **FILTRON** COMPANY INC., FLUSHING, LONG ISLAND, NEW YORK

LARGEST EXCLUSIVE MANUFACTURERS OF RF INTERFERENCE FILTERS

At COIL WINDERS, INC.
Westbury, New York . . .

They cast their lot with SCOTCHCAST!

REG. U.S. PAT. OFF.
BRAND

Before settling on "SCOTCHCAST" Resin to encapsulate their coils, Coil Winders, Inc., Westbury, New York, tried many variations of standard insulating methods. They wanted something *better* than just good. They wanted extremely high moisture resistance, superior physical and electrical properties. So they cast their lot (over 30,000 coils in the last year) with "SCOTCHCAST"!

"SCOTCHCAST" is a two-part liquid epoxy-type resin which when combined with a suitable hardener, quickly cures into a solid, shock-resistant, moisture-resistant plastic. It is available with a wide range of properties, in rigid, semi-rigid and flexible forms.

And remember this: Unlike other resins, "SCOTCHCAST" sticks tight to terminals and leads, most metals, plastics and conductors, yet it's unaffected by acids, alkalies, solvents, oils and water.

For complete information, write Minnesota Mining and Manufacturing Company, Dept. CA-95, St. Paul 6, Minn. Learn how "SCOTCHCAST" can save you time and money, how it can do things you'd never dream an insulating material could do! Write today!

PRODUCT OF 3M RESEARCH

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POTENT POWER + **SMALL SIZE**

Up to 5100 mmf at 300 vDCw
Up to 3900 mmf at 500 vDCw

(size) Length 3/4" average Width 7/16" average Thickness 3/16" DM-20 shown actual size

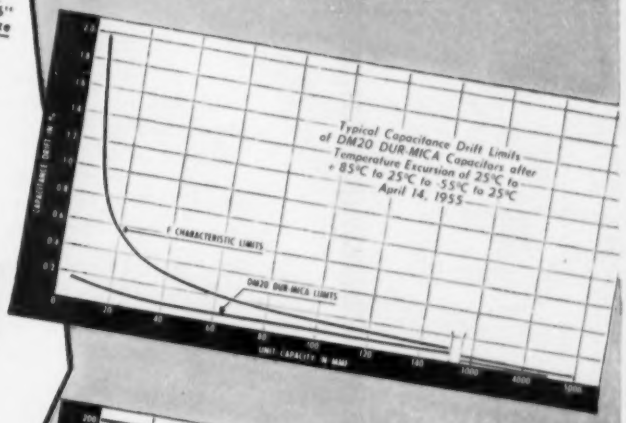
El-Menco Dur-Mica DM-20

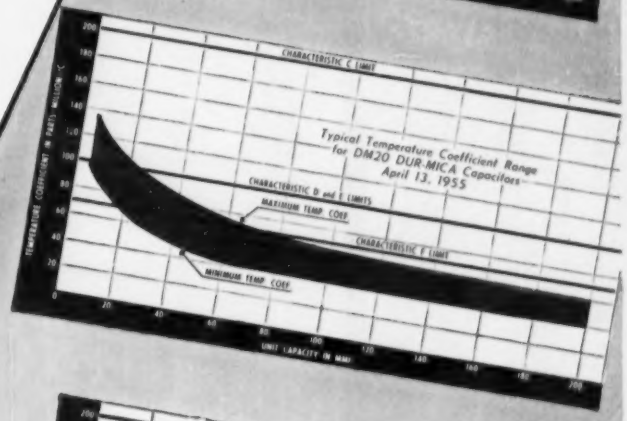
DIPPED MICA CAPACITOR WITH PARALLEL LEADS

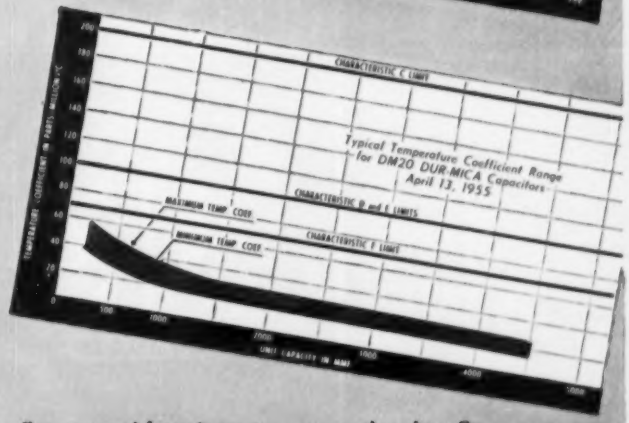
PEAK PERFORMANCE
ideal for new miniatured designs and printed wiring circuits

MEETS ALL HUMIDITY, TEMPERATURE AND ELECTRICAL REQUIREMENTS OF
MIL-C-5 Specifications!

to meet modern miniature requirements


Typical Capacitance Drift Limits of DM20 DUR-MICA Capacitors after Temperature Excursion of 25°C to +85°C to 25°C to -55°C to 25°C
April 14, 1955
CAPACITANCE DRIFT IN %
UNIT CAPACITY IN MMF
CHARACTERISTIC C LIMITS
DM20 DUR-MICA LIMITS


Typical Temperature Coefficient Range for DM20 DUR-MICA Capacitors
April 13, 1955
TEMPERATURE COEFFICIENT IN PARTS/MILLION/°C
UNIT CAPACITY IN MMF
CHARACTERISTIC C LIMIT
CHARACTERISTIC D and E LIMITS
MAXIMUM TEMP COEF
MINIMUM TEMP COEF
CHARACTERISTIC E LIMIT


Typical Temperature Coefficient Range for DM20 DUR-MICA Capacitors
April 13, 1955
TEMPERATURE COEFFICIENT IN PARTS/MILLION/°C
UNIT CAPACITY IN MMF
CHARACTERISTIC C LIMIT
CHARACTERISTIC D and E LIMITS
MAXIMUM TEMP COEF
MINIMUM TEMP COEF
CHARACTERISTIC E LIMIT

TEST IT AND COMPARE!

- El-Menco's Dur-Mica DM20 costs even less than our famous molded mica capacitors.
- Provides greater versatility — wider applications.
- Tougher phenolic casing assures *longer-life* and *greater stability* through wide ranges in temperature.
- Parallel leads simplify application in transistor and sub-miniature electronic equipment including printed circuits for military and civilian use.

For Extreme Miniaturization Use Our DM15

DM15 — Up to 510 mmf at 300 vDCw
Up to 400 mmf at 500 vDCw

Available in 125°C operating temperature. Minimum capacity tolerance available ±½% or 0.5 mmf (whichever is greater).

For your special requirements — we are pleased to offer information and assistance. Write for free samples and catalog on your firm's letterhead.

El-Menco Capacitors

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To the man with a problem in

The engineer with an eye on new horizons finds kindred souls at the James Knights Company. For this is the home of today's top crystal engineers, and the source of today's most advanced crystal product developments.

Here you will find mature vision—a recognition that with channels narrowing, in an already congested radio spectrum, frequency control tolerances must narrow too. We are meeting that challenge.

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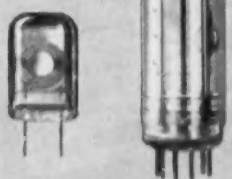
JK-09 OVEN

Precision Temperature Control, compact in design and capable of maintaining a set temperature around crystal with less than ± 1°C variation over the range of −55°C to +100°C.

Miniaturized Precision "Glasline" Crystals, in a range from 1000 cycles to 150 mc, combining minimum size with maximum stability.



Crystals for the Critical

JK

PRODUCTS

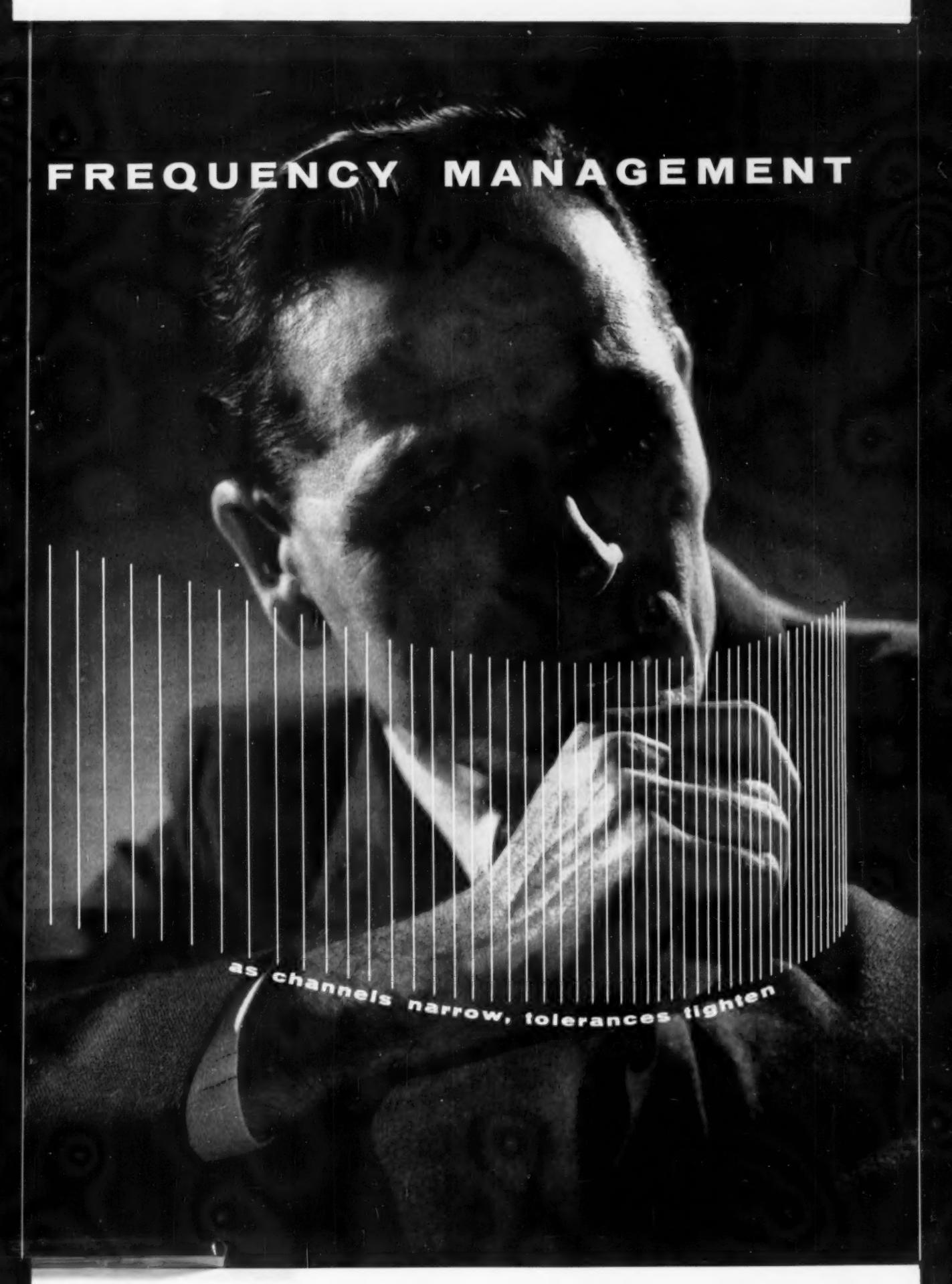
Precision "Glasline" Crystal Filters, crystals plus all required circuit components including termination transformers sealed in a vacuum. A complete plug-in crystal filter designed for optimum performance and reliability. Frequency range and performance characteristics available upon request.

"Thermystal", an advance design that combines plug-in simplicity with extreme precision. Calibration accuracy: ± (1 cycle + .0001%) Temperature stability: 30 to 900 kc ± .0001%, 1000 kc to 150 mc .00005%. Oven temperature varies less than ± 1°C over range of −55°C to +85°C. Secular stability: Less than .001% per year. Oven power: 6.3 V @ 1.5 amp. max.

JK-THERMYSTAL

Complete Precision Plug-in Signal Source, a complete, precise crystal controlled transistorized oscillator compactly designed within the famous JK-09 oven, affording fixed temperature and humidity environment for transistor as well as all circuitry elements.

TRANSISTORIZED THERMYSTAL OSCILLATOR


FREQUENCY MANAGEMENT
as channels narrow, tolerances tighten

Stretching the Path of an Electronic Pulse

Military coding equipment takes one pulse and inserts it into a delay line and in effect sends it over a number of paths, each of different lengths. Combining the output of the paths gives a pulse train with pulses spaced in accordance with artificial length of the path. Ordinarily the flexibility of the equipment is limited by the fixed taps in the delay line and the accuracy is established by auxiliary circuitry.

Now Admiral research has developed a completely new type of delay line which is infinitely variable within its over-all capacity. It is adjustable with the greatest facility for any desired interval. The accuracy of this line is limited only by the accuracy of the measuring equipment. Moreover, the Admiral delay line requires less complicated switching apparatus. Weight and bulk are reduced. Fewer components permit faster production at lower cost. Here is one more example of Admiral's capabilities in the field of military electronics. Address inquiries to:

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OPERATING TEMPERATURE -65°C to +125°C

High Heat and Humidity Resistance • Low Cost

Good-ALL capacitors

The Trend is to Seramics!

COMPARITIVE SERAMELITE SIZES

CAP MFD.	VOLTS	PAPER Dielectric Dia. Length	"MYLAR" Dielectric Dia. Length
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.0022	200	5/16 x 1	7/32 x 27/32
.0047	200	5/16 x 1	7/32 x 27/32
.01	200	5/16 x 1	7/32 x 27/32
.022	200	5/16 x 1	7/32 x 27/32
.047	200	3/8 x 1 1/4	5/16 x 1
.1	200	17/32 x 1 5/16	23/64 x 1
.22	200	17/32 x 1 5/16	7/16 x 1 1/4
.47	200	23/32 x 1 3/8	17/32 x 1 5/16
1.0	200	3/4 x 2 1/4	5/8 x 1 7/8

High performance and low comparative cost make **GOOD-ALL "SERAMELITES"** the number one choice.

Tubular ceramic case and new thermo-setting end seal will not lose its bond under any rated operating temperature.

Seramic plastic combination guarantees tightest possible seal against heat and humidity.

Good-All Seramelites are available with "MYLAR"* or paper dielectric. "MYLAR" offers the important advantages of high Insulation Resistance, Smaller Size and Higher Operating Temperatures (up to 125°c).

*Du Pont Trade Mark for its Polyester Film.

For further information, write direct or contact our nearest sales representative

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Sure, you could pay less for an ordinary knob, but the premium price of the Raytheon Standard Control Knob is well worth the difference! Here's why:

Raytheon knobs conform to government specifications for material, high and extreme temperature, humidity, salt spray, vibration, impact and torque. They are handsomely designed and molded of "Tenite II." They have anodized aluminum inserts with dual Allen head set screws. Most important, Raytheon knobs offer the smartly turned professional look that adds so much to the fine appearance of your product.

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Let us send you complete information on the finest control knobs available today. Write Dept. 6120, or see your electronic supplier.

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Prices range from 69¢ to $3.10

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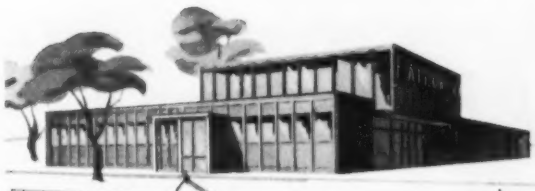


Los Angeles, Cal.

Fairchild announces the opening of a new plant in Los Angeles, California. The new plant will expand the manufacturing, sales and service activities of Fairchild's Potentiometer Division to provide equal facilities both in the East and the West. It will meet the growing need for its products by the expanding electronic and avionic industries on the West Coast. A complete line of potentiometers will be manufactured and the new plant will be staffed to provide complete engineering and fast delivery service.

Hicksville, L.I., N.Y.

AVAILABILITY AND SERVICE

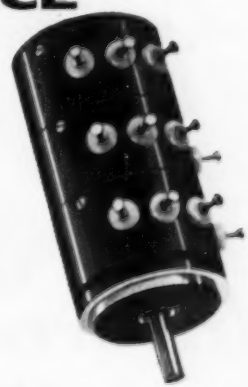
from L.I. to L.A.

The opening of Fairchild's new West Coast plant means that henceforward the name Fairchild will not only stand for the finest in precision potentiometers . . . it will mean faster delivery and better service, too. You will be able to get complete engineering service, quotations, order handling, delivery and repair from either plant, whichever is most convenient to you.

This is another example of how Fairchild can always give you the answers, no matter what factors govern your choice of precision potentiometers. Write Potentiometer Division, Fairchild Controls Corp., a subsidiary of Fairchild Camera and Instrument Corp., Dept. 140-66A1.

EAST COAST
225 Park Avenue
Hicksville, L.I., N.Y.

WEST COAST
6111 E. Washington Blvd.
Los Angeles, Cal.



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PRECISION POTENTIOMETERS

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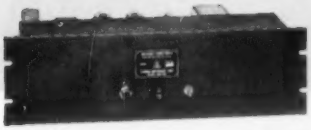
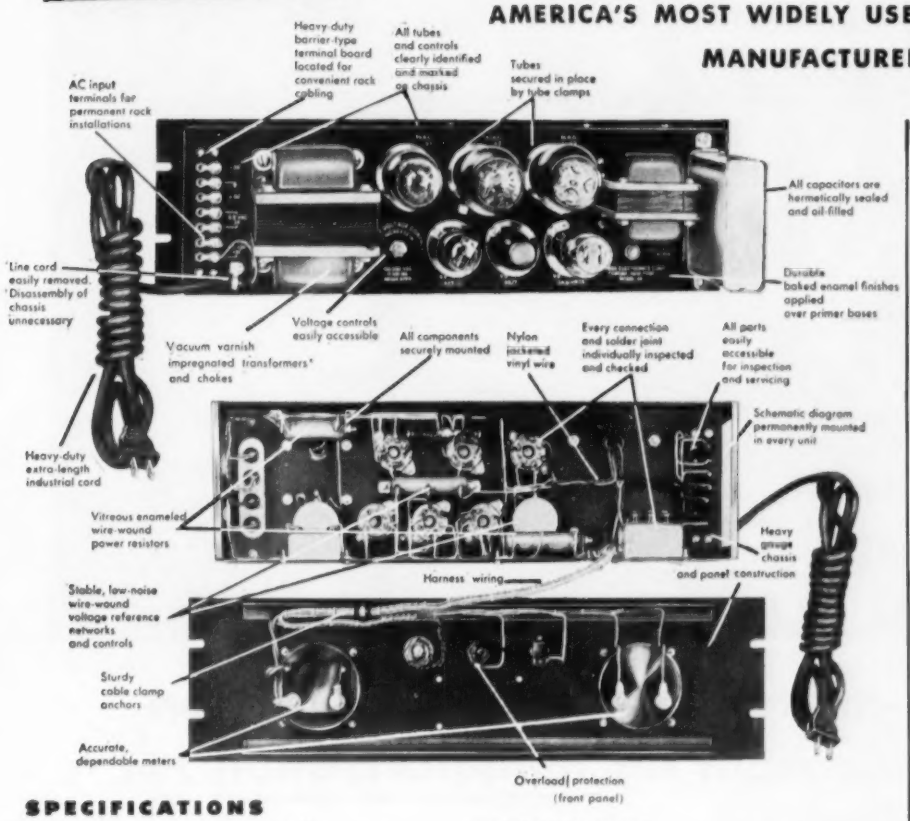
COMPLETE POWER SUPPLY DEPENDABILITY FOR AS LITTLE AS $57.50



AMERICA'S MOST WIDELY USED POWER SUPPLIES, MANUFACTURED AND GUARANTEED BY LAMBDA


Heavy-duty barrier-type terminal board located for convenient rack cabling
All tubes and controls clearly identified and marked on chassis
Tubes secured in place by tube clamps
AC input terminals for permanent rack installations
All capacitors are hermetically sealed and oil-filled
Durable baked enamel finishes applied over primer bases
Line cord easily removed. Disassembly of chassis unnecessary
Voltage controls easily accessible
Vacuum varnish impregnated transformers and chokes
All components securely mounted
Nylon jacketed vinyl wire
Every connection and solder joint individually inspected and checked
All parts easily accessible for inspection and servicing
Schematic diagram permanently mounted in every unit
Heavy-duty extra-length industrial cord
Vitreous enameled wire-wound power resistors
Heavy gauge chassis and panel construction
Harness wiring
Stable, low-noise wire-wound voltage reference networks and controls
Sturdy cable clamp anchors
Accurate, dependable meters
Overload protection (front panel)

Model 28
200-325 VDC, 0-100 MA
$57.50

Model 29
100-200 VDC, 0-100 MA
$67.50

Model 28M (with meters)
200-325 VDC, 0-100 MA
$87.50

Model 29M (with meters)
100-200 VDC, 0-100 MA
$97.50

Rack models 28, 28M, 29 and 29M are long-lasting, dependable sources of power that deliver "workhorse" service . . . yet cost as little as $57.50 (for Model 28).

Intended primarily for fixed voltage use, these compact supplies are precision-built, as carefully engineered and quality-controlled as the most intricate models. They provide a convenient, low-cost power source for auxiliary equipment, also are well suited to production line applications.

SPECIFICATIONS

DC OUTPUT (regulated for line and load):
Voltage and Current

Models	Voltage Range[1]	Current Range[2]
28, 28M	200-325 VDC	0-100 MA
29, 29M	100-200 VDC	0-100 MA

[1]Voltage is continuously variable over entire range.
[2]Current rating applies over entire voltage range.

Regulation (line) . . . Better than 1%. For input variations from 105-125 VAC.

Regulation (load) . . . Better than 1%. For load variations from 0 to 100 MA.

Internal Impedance . . . Less than 10 ohms.

Ripple and Noise . . . Less than 10 millivolts rms for Models 28, 28M. Less than 5 millivolts rms for Models 29, 29M.

Polarity . . . Either positive or negative may be grounded.

AC OUTPUT (unregulated): 6.5 VAC at 3A (at 115 VAC input) . . . Allows for voltage drop in connecting leads. Isolated and ungrounded.

AC INPUT . . . 105-125 VAC, 50-60 CPS, 120 watts.[3]

[3]With all outputs loaded to full ratings and input at 125 VAC.

AMBIENT TEMPERATURE AND DUTY CYCLE . . . Continuous duty at full load up to 50°C (122°F) ambient.

OVERLOAD PROTECTION:
External Overload Protection . . . AC fuse, front panel.

INPUT AND OUTPUT CONNECTIONS: Heavy duty barrier terminal block, rear of chassis. 8 foot heavy duty rubber covered line cord with integral molded plug, also supplied.

METERS:
Output Voltage . . . 3½" rectangular voltmeter on meter models.
Output Current . . . 3½" rectangular milliameter on meter models.

CONTROLS:
DC Output Control . . . Screw driver adjusting control, rear of chassis.
AC Switch . . . Front panel.

PHYSICAL DATA: Mounting . . . Standard 19" rack mounting.
Size . . . 5¼" H x 19" W x 8" D.
Weight . . . 19 lbs. net, 23 lbs. shipping weight.
Panel Finish . . . Black ripple enamel (standard). Special finishes available to customer's specifications at moderate surcharge.

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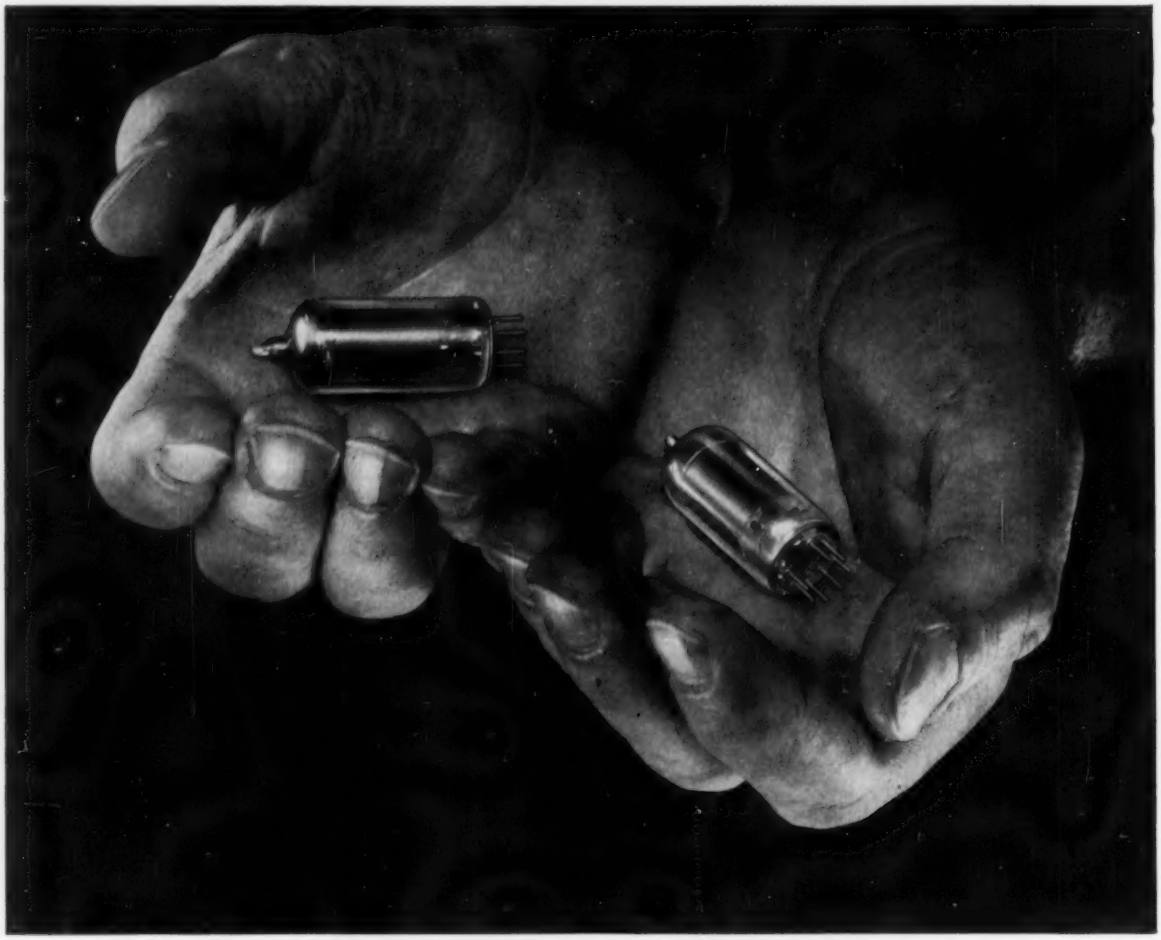

Vacuum-melted metals — new weapon in the fight for miniaturization . . .

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The reason these alloys are superior is easy to explain. *Vacuum-melting removes unwanted gaseous impurities and inclusions — literally sucks them from the molten metal.* Result: close composition control . . . high-purity, gas-free metals that far outperform those made by conventional air-melted methods.

Vacuum Metals Corporation, pioneer in development and leading producer of vacuum-melted and cast metals, has a wide variety of these unique new metals available for electrical and electronic uses. If you have an application you believe they can improve, please write, giving full details. Our engineers will give your letter prompt, careful attention. *Vacuum Metals Corporation, P. O. Box 977, Syracuse 1, N. Y.*

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WHILE NEW YORK CITY SLEEPS

Amperex® VHF TUBES STAND GUARD

. . . and over 70,000 Amperex 5894 or 6252 VHF transmitting tubes are now in use all over the country, in approved equipment by Fire Departments, Civil Defense, Police and other Municipal Emergency Services . . .

because Amperex TUBES have proven MOST DEPENDABLE

If disaster should strike, will your communication equipment meet the test? In time of disaster, there is no substitute for dependability — even initial cost becomes secondary! Long life, ruggedness and reliability were the watchwords in the final selection of these tubes. If you are planning new fixed or mobile stations, insist on AMPEREX type 5894 or 6252 to be sure!

Type 6252
$22.00 Net

Type 5894
$22.00 Net

COMPARISON PROVES AMPEREX SUPERIORITY
Maximum Plate Input & Voltage VS Frequency
(Push-pull, Class C Operation)

Service ICAS	Frequency Band (Mc)	AMPEREX 6252 Plate Input Watts	AMPEREX 6252 Plate Volts	Nearest Rated Competitive Tube Plate Input Watts	Nearest Rated Competitive Tube Plate Volts
Plate	144-148	72	600	49	435
Modulated	220-225	72	600	44	370
Telephony	420-450	51.5	475	31	300

The AMPEREX 6252 ICAS higher voltage and input ratings show the advantage of the independently suspended anode construction which eliminates the need for internal insulation. Competitive tubes use mica insulators between the plate and the rest of the internal structure, resulting in low maximum anode voltage and greater derating at higher frequencies.

Sonar Radio Corporation's FCDA-approved, Model CD-2 Transmitter, designed for CD fixed and emergency operation uses the Amperex type 6252.

Radio Engineering Laboratories' Type 715 Transmitter, used by New York City's Fire Department, employs the Amperex type 5894.

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AMPEREX ELECTRONIC CORPORATION
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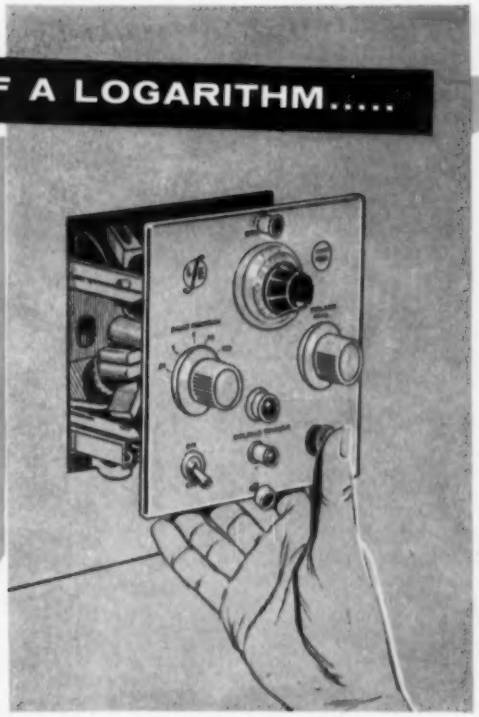
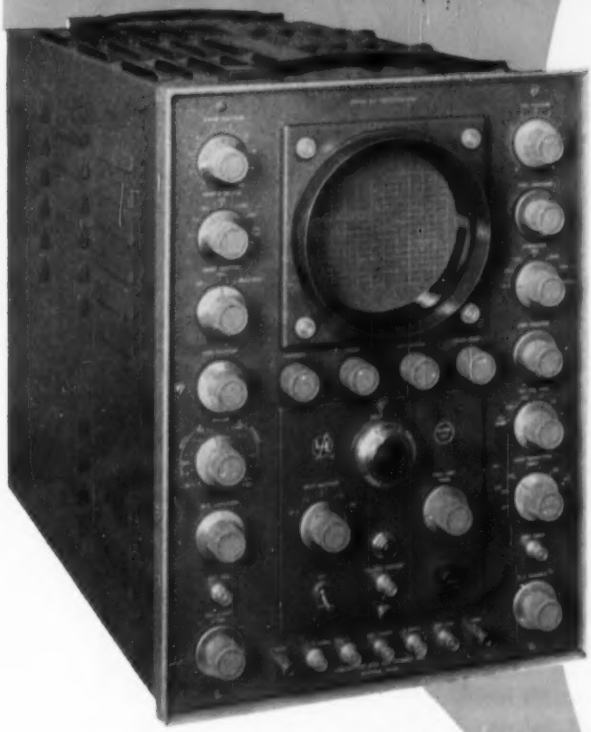
LFE'S *easy-SIX*→ 411 OSCILLOSCOPE





We're frankly throwing out our chests.

In the 411 Oscilloscope we've come up with a Jack-of-all-trades that's master of every one! That's why we call it the "Easy-Six". This high-accuracy scope is so *easy* to operate, yet it features *six* X-axis plug-in units and all the bandwidth and sensitivity needed for advanced electronic research.

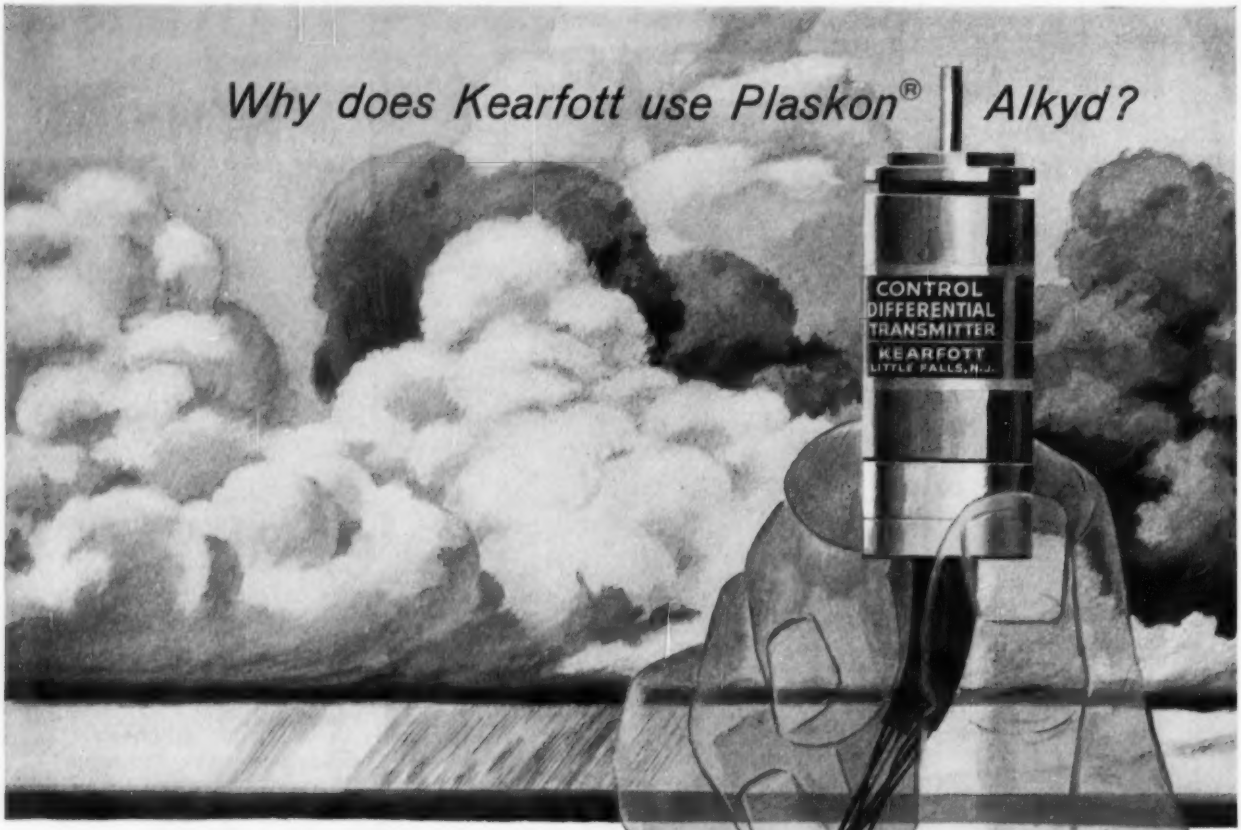
We're pleased as Punch to have engineered such a terrific scope, and we know you'll be just as pleased to use it. Here are some of the ingenious features of the "Easy-Six" that have put satisfied smiles on our customers' faces.

- **TRIGGER** — Only two controls needed — trigger selector and trigger amplitude.
- **DELAY**—One switch only. Simply turn sweep selector switch to delay. No additional cables necessary.
- **SWEEP SPEEDS** — No more than two controls needed to vary Sweep Speed. Direct-reading, incrementally variable Sweep Ranges, whose accuracy is maintained uniformly, avoid ambiguity and interpolations.
- **DELAY SYSTEM** — Delay control is calibrated *directly* in microseconds of delay. Same trigger for the delay as for the undelayed sweep.
- **VOLTAGE CALIBRATOR** — May be operated simply by turning the signal calibrator switch.

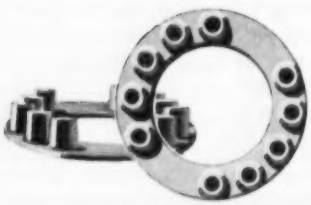
For specifications and more details about the "Easy-Six", write for our informative, free bulletin and the name of the LFE Engineering Representative nearest you.

LABORATORY FOR ELECTRONICS, INC.
75 Pitts Street, Boston 14, Mass.

Why does Kearfott use Plaskon® Alkyd?



NO OTHER PLASTIC DOES



Servo-motor terminal-rings must have strength, be dimensionally stable and have excellent insulating properties to do their job effectively. PLASKON Alkyd Molding Compound meets all of these requirements and, thereby, contributes to the outstanding quality of the Kearfott units.

Matching end-cap and cover of synchro unit are made with extremely close tolerances in order to fit together exactly. PLASKON Alkyd is one of the few materials with sufficient strength in small sections to be acceptable for this application.

SO MANY JOBS SO WELL!

Highly exacting electronic devices are an old story to Kearfott Company, Inc., a leading manufacturer of miniature remote-control systems for aircraft and industry. One of Kearfott's synchro units (the smallest of its type on the market) is only ¾" in diameter. This unit requires components made of a material with unusual talents. These include: 1. great strength and dimensional stability 2. arc-resistance and dielectric strength 3. resistance to humidity, fungus, shock and vibration.

After much experimentation, reinforced PLASKON Alkyd Molding Compound was found to be the *one* material that had all the required properties. It has replaced *all other plastic materials* in this application.

In motor housings, end forms, brush holders and blocks where strength, dimensional stability and insulating properties are essential, PLASKON Alkyd has proved itself to be indispensable. Why not find out more about this unique material? Write today for complete technical data on our glass or mineral-filled Alkyd formulations.

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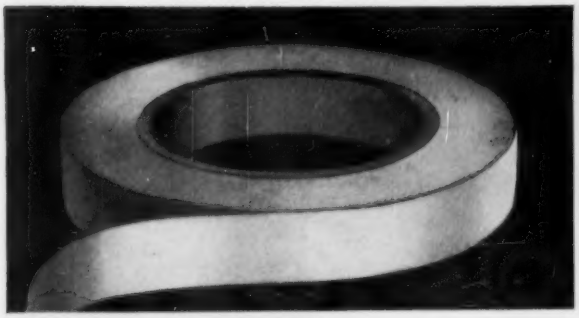
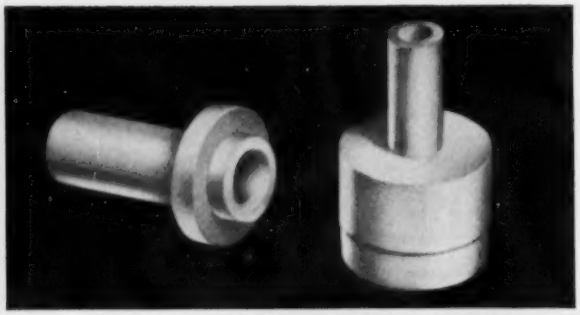
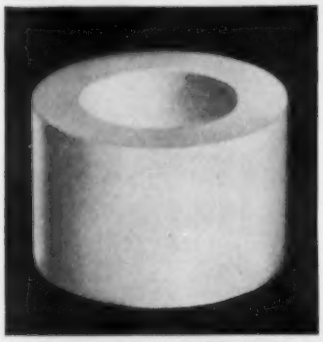
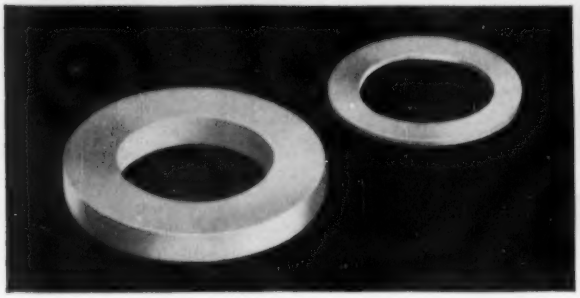
For further information on PLASKON Plastics and Resins, address BARRETT DIVISION, Allied Chemical & Dye Corp., 40 Rector Street, New York 6, N. Y. HAnover 2-7300.

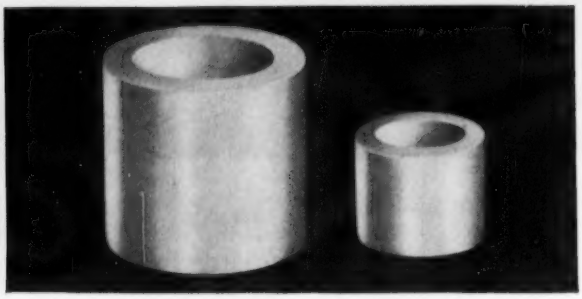






TRY SOLVING YOUR TOUGHEST PROBLEMS WITH R/M Teflon*





Thousands of engineers have found that "TEFLON" has what it takes to solve some really tough problems in the electronics and electrical manufacturing fields. They have also found R/M, with its unmatched skill, experience and facilities, a tremendous help in solving those problems. For R/M has been working with this plastic ever since it first was produced. If you have a problem the chances are good that R/M has encountered it and already worked out a solution.

The several different products pictured above indicate R/M's versatility in "TEFLON" manufacture. We can fabricate parts to your own specifications or supply you with "TEFLON" in the form of rods, sheets, tubes or tape. For further information, write today.

PROPERTIES OF "TEFLON"

High dielectric strength • Moisture absorption zero • Unaffected by weather • Excellent heat stability up to 500°F. in continuous operation • As tape leaves no carbon residue along discharge path • High impact resistance • Nonadhesive • Stretches easily • Tensile strength 1500-2500 psi.

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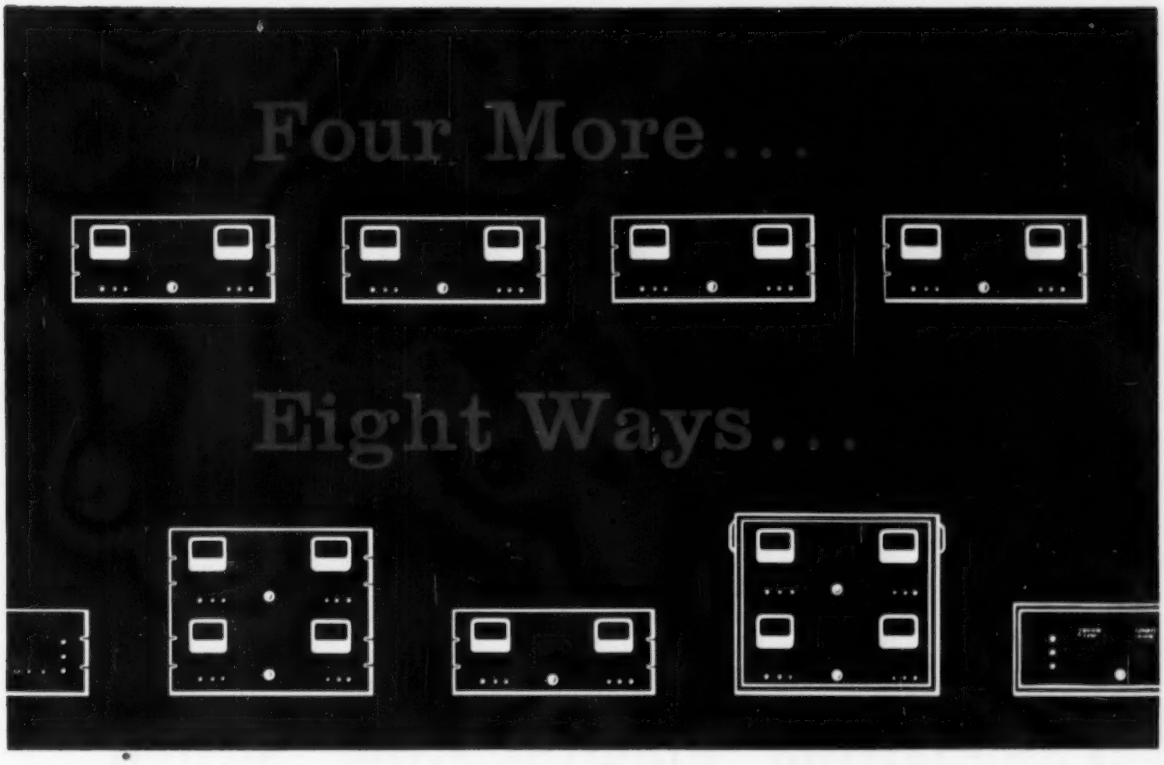

NJE has added four more basic ranges to the most complete power supply line in the industry.

Each one is the result of dozens of custom inquiries, indicating a need for such a stock model.

Each is available eight ways—as always—rack, rack-with-meters, cabinet, cabinet-with-meters, and similarly in our 4-way "duals", to double the range in parallel, series-aiding, series-opposing and isolated modes.

Each exemplifies the clean, conservative design and mass-production economy you have come to identify with NJE—the leader in the power supply field.

Model	Regulated Voltage Range Volts DC	Current Range MA DC	Line Regulation %	Load Regulation %	Unregulated Filament Supplies	Price (Rack - No meters)
S-150	200-325	0-200	0.3	0.3	Two - 6.35V @ 3A	$ 96.00
S-250	100-200	0-200	0.5	0.5	Two - 6.35V @ 3A	$104.00
S-350	200-325	0-300	0.3	0.3	Two - 6.35V @ 5A	$137.00
S-900	0-600	0-300	0.3 or 0.5V	0.3 or 0.5V	Two - 6.35V @ 5A	$225.00

Fixed or variable Bias supplies available. Meters, $30.00 add'l. Cabinet, $20.00 add'l.

Write for Catalog S-5

For our complete line of electronic power supplies See electronics Pp. 113-120 BUYERS' GUIDE

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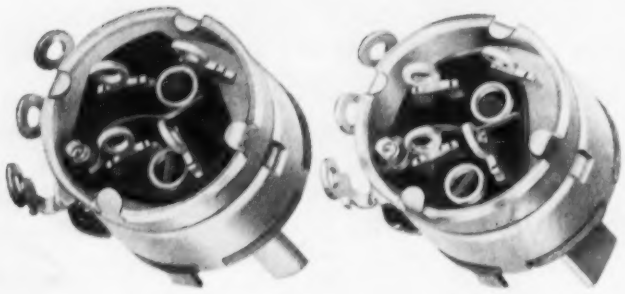
POWER SUPPLIES UNLIMITED

MALLORY



ON OFF

Switch life is greatly increased by this new contact action. Note how "floating" rings of special Mallory alloy make and break the line circuit as the shaft is rotated—providing a continually changing contact surface.

Long-lasting "Floating Ring" Switch* Now Available on Mallory Controls

NEW CONTROL SWITCH WITH PUSH-PULL ACTION

Try this sales-worthy feature in your new set designs. The on-off switch works by push-pull action. Push the shaft and the set turns off . . . pull, and the set turns on *at the same volume setting.* The set owner doesn't have to re-adjust volume, and the control element lasts far longer because it is moved only for minor volume changes. This switch uses the same type of "floating ring" contacts as the new rotary switch. It is available for use with all Mallory carbon controls.

A NEW TYPE rotary switch, embodying unique contact action, is now available on Mallory carbon controls. Make and break is accomplished by spring-snapped motion of rings of special Mallory contact alloy, with positive self alignment. The rings "float" on pins so they can rotate with each operation.

Extremely long service life, proved on actual tests. The floating action spreads wear and arc erosion around the whole circumference of the rings . . . gives cleaner make and break.

Protection against overload damage. The snap spring which moves the contacts carries no current . . . won't heat and anneal when overloads occur.

Positive "feel". Positive snap action "feel" provides definite assurance of switch operation, with minimum torque requirement.

Available for use with all Mallory carbon controls, the new switch *costs no more* than conventional designs. In combination with high stability, long-wearing, low-noise Mallory resistance elements—in values from 250 ohms to 10 megohms—it gives you unequalled control performance. For full facts, write or call Mallory today.

Expect more . . . Get more from

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MALLORY

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Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.

*Patent applied for

electronics

W. W. MacDONALD, Editor

SEPTEMBER • 1955

CROSS TALK

►**MECHANIZED PRODUCTION** . . . History will record 1955 as a year of transition in the electronics industry. This is the year to which engineers of the future will attribute the beginning of mechanized production.

Many of the techniques required for mechanized production have long been in the wood. Nearly thirty years ago a line of radio sets was wired by flowing molten metal into grooved plastic boards; stamped, printed or etched loops, coils and subassemblies are by no means new. Component leads have been semi-automatically bent, clipped or otherwise prepared for assembly for many years. Dip soldering has been extensively used since the war. ELECTRONICS published a story about a completely hygienic machine-made radio in '48. In '43 we described an almost-human production tester.

Until now these fascinating techniques have not been too successfully used in combination. Nor is mechanized production involving them yet completely devoid of bugs. An extensive survey of the industry (page 137) indicates, however, that we are well on the road toward a combination of fabrication, assembly and testing methods that can hold the price line despite rising labor costs, insure rapid production of highly specialized apparatus on short notice and increase equipment reliability.

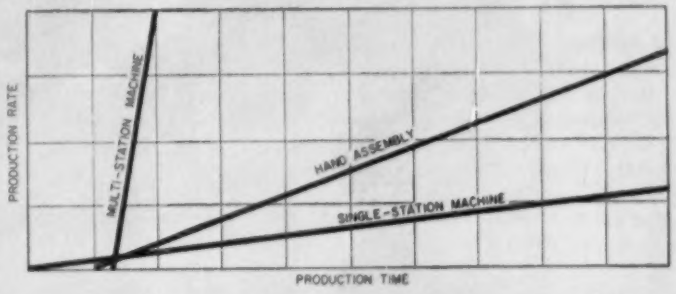
In the past a plurality of proposed approaches to mechanization muddied the waters. Possible methods of "printing" wiring have been as numerous as leaves on the trees. There has been a healthy difference of opinion as to whether or not component parts themselves should be printed. Several methods of interconnecting parts have challenged the dominion of heat, lead and tin. Builders of assembly machines couldn't make up their minds how far, or how fast, to carry the untouched-by-human-hands torch. Even the ingenious early designers of automatic testers fluctuated between a circuit-by-circuit and an overall-performance check.

Now the electronics industry has made up its mind about mechanized production with sufficient unanimity to get going. It has finally concluded that regardless of product, or size of run, some sort of mechanization more closely approaching a pushbutton age is necessary.

Etched wiring has at least momentarily achieved almost universal acceptance. Component parts made expressly for semi-automatic or fully automatic insertion dominate planning for the immediate future. Dip soldering is becoming a conventional method of interconnecting parts. One type of assembly machine is built to handle short runs of critically complex equipment while another seems more at home on long runs of radio and tv sets, and there are others betwixt and between. Automatic testers constitute the weakest link in the chain, but the incentive to develop them further is increasing as the other techniques fall into place.

Two important lessons have been learned in the industry's period of gestation on the subject of mechanized production. One, that any attempt to jump from hand operation to fully automatic methods in one fell swoop is likely to fail. Two, that machines and setups and systems must be sufficiently flexible or open-ended to permit the frequent changes that are so necessary in our field.

THREE ASSEMBLY METHODS . . .



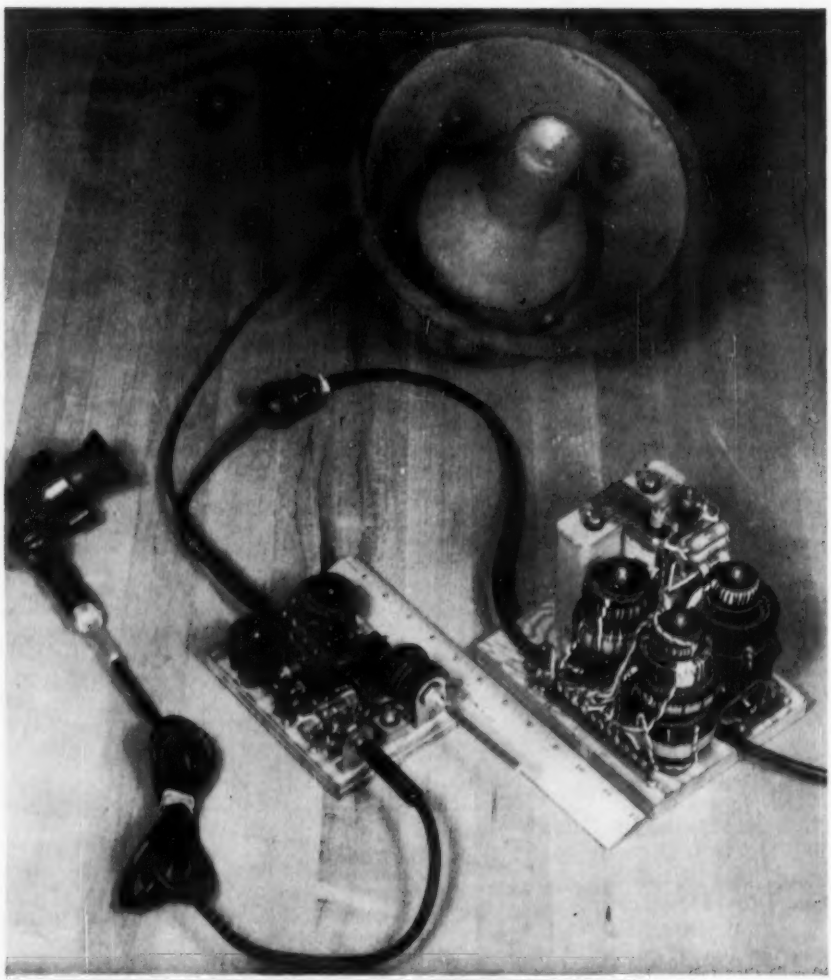
The speed with which a production line inserting parts on wiring boards can get started, the rate at which production can be stepped up and the quantity ultimately obtainable from a given set of facilities depend upon the approach chosen by engineers (page 137)

All-Magnetic

SUMMARY —— Three cascaded magnetic frequency triplers provide 10,800-cps carrier from 400-cps line for tubeless audio amplifier with zero warmup time. Potting of entire unit gives ruggedness for aircraft applications

By J. J. SUOZZI and E. T. HOOPER

Magnetics Division
U. S. Naval Ordnance Laboratory
White Oak, Maryland



Experimental model of tubeless audio amplifier. Assembly can be packaged in a unit 5 in. x 5 in. x 6 in.

Audio Amplifier

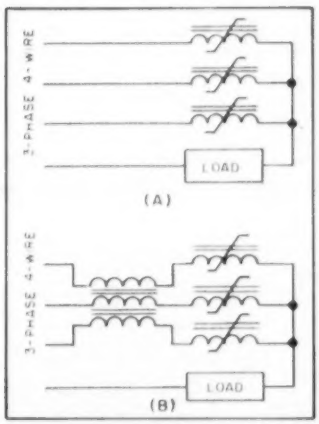


FIG. 1—Basic three-phase tripler (A) and single-reactor tripler (B)

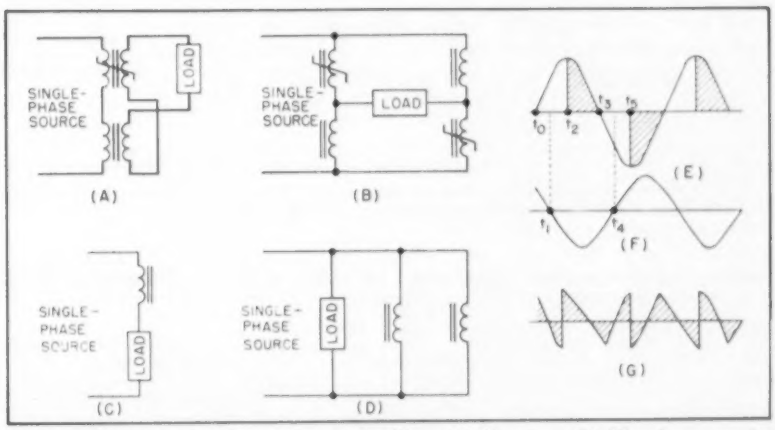


FIG. 2—Single-phase transformer-type tripler (A) and bridge type (B). Waveforms are for equivalent circuits (C) and (D) of bridge circuit

USE of magnetic amplifiers for audio amplification necessitates generation of a carrier frequency at least three times the upper bandwidth limit. Vacuum-tube oscillators and rotating machines are unsuitable for this function because they introduce short life or moving parts, thus losing the major advantages of magnetic amplifiers. Switching transistors associated with saturable reactors are a promising high-frequency source but are still in a developmental stage.

The combination of static magnetic frequency multipliers of improved design with a half-wave bridge-type magnetic amplifier has led to the development of an audio system of low distortion, good bandwidth and practical size.

Magnetic Power Supply

The high-frequency power supply consists of three cascaded frequency triplers of the magnetic-core type.

A carrier of 10,800 cps was chosen to obtain the least amount of frequency multiplication while allowing a sufficient bandwidth to be obtained from a half-wave magnetic amplifier. Higher bandwidth and fidelity could be obtained by using a still higher carrier frequency.

Three frequency triplers are cascaded to obtain the carrier from the 400-cps line. The first stage is a three-phase tripler followed by a modified transformer-type and a bridge-type single-phase tripler.

The basic three-phase tripler is shown in Fig. 1A. The modified circuit in Fig. 1B was used in the amplifier. This tripler consists of a single linear reactor with three separate windings allowing a combination of the action of separate reactors and the single-winding reactor depending on the amount of coupling. The output of the tripler can be fed into a tuned circuit to obtain a good sinusoidal waveform. In this case, only a capacitor was needed.

Reactor Design

The design of a basic three-phase tripler as shown in Fig. 1A is straightforward. Each saturable reactor is designed to fire between 120 and 137 deg depending on whether the core material is sharply saturating or not. If inductance is used in series with each saturable reactor, a firing angle of 120 deg will be safe even with very sharply saturating material, since circulating currents between phases will be minimized.

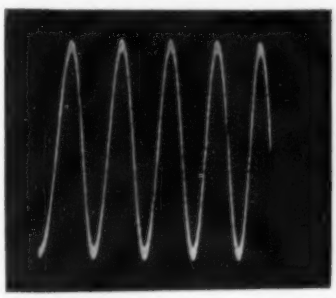


FIG. 3—Output waveform of magnetic frequency tripler

The number of turns for a given reactor can be computed from $E = 4.44\ BNAf \times 10^{-8}$ where E is the rms value of phase voltage (for 120-deg firing angle, use $\frac{3}{4}\ E$), B is residual flux density in gauss, N is number of turns, A is cross-sectional area of core in sq cm and f is line frequency in cps.

This formula is approximate. It may be necessary to add or subtract a few turns for exactness. The three-phase tripler is capable of operating at efficiencies as high as 98 percent since the only appreciable power losses are in the core of the saturable reactors and in the I^2R losses of the windings. The tripler used in the first stage of the power supply has an overall efficiency of 90 percent.

Single-Phase Tripler

Operation of single-phase triplers depends on the superposition of a sinusoidal and distorted voltage or

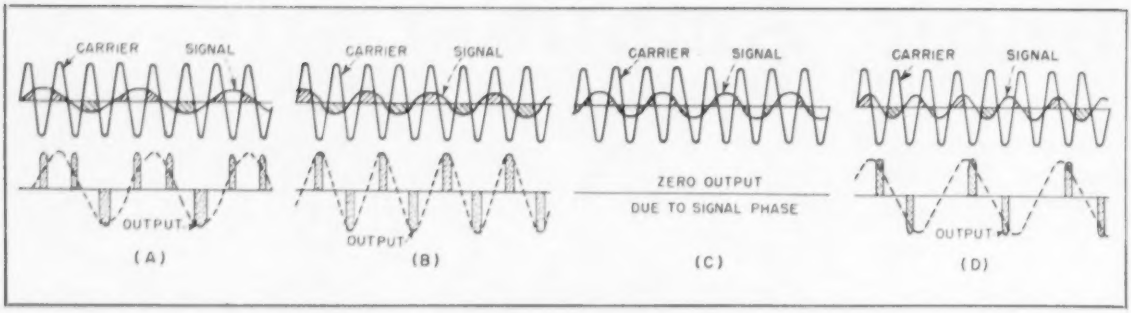


FIG. 4—Distortion effects at signal frequencies one third (A), one half (B) and (C), and two thirds of carrier frequency (D). At half carrier frequency output is reduced depending on phase relationship of signal and carrier

Table I—Reactor and Transformer Winding Data for Frequency Multiplier

	Core			Windings		
	No.	Material	Size in Inches	No.	Wire Size	Turns
SR_1 SR_2 SR_3	1	¾ × 0.0002 Orthonol tape	1¼ i-d, 1¾ o-d	1	No. 20	260
SR_4	1	⅜ × 0.0002 Orthonol tape	1¼ i-d, 1¾ o-d	1	No. 20	140
SR_5	1	¼ × 0.001 Orthonol tape	⅞ i-d, 1 o-d	2	No. 23	130
LR_1	2	Western Electric No. 478438 or Arnold Eng. No. A-438281-2 Moly-Permalloy Dust		3	No. 20	100
LR_2	2			2	No. 20	100
LR_3	1			1	No. 16	100
LR_4	1			1	No. 16	75
LR_5	1			2	No. 23	70
LR_6	2	Western Electric No. 467585 or Arnold Eng. No. A-585079-2 Moly-Permalloy Dust		1	No. 16	30
LR_7	1	Western Electric No. 476930 or Arnold Eng. No. A-930157-2 Moly-Permalloy Dust		1	No. 16	26
T_1	1	Western Electric No. 467585 or Arnold Eng. No. A-585079-2 Moly-Permalloy Dust		2	No. 23 No. 23	420 60

current. A linear reactor is used to produce the sinusoidal voltage and necessary phase shift while a saturable reactor produces the desired distorted waveform. These two voltages are combined by the transformer-type circuit of Fig. 2A or the bridge-type circuit of Fig. 2B. Figure 2C and Fig. 2D show the equivalent circuits of the bridge-type tripler.

Assuming the saturable reactor characteristic has a rectangular loop with no width and that the saturated impedance is zero while the unsaturated impedance is infinite, the saturable reactor is unsaturated during time t_o to t_2 in Fig. 2E and the equivalent circuit of the tripler becomes as shown in Fig. 2C. During this time, the load voltage is sinusoidal and lagging with a phase angle of arctan X_L/R. This waveform is shown in Fig. 2F but with 180-deg phase displacement due to the circuitry.

From t_2 to t_4, the saturable reactor is saturated, and the equivalent circuit becomes as shown in Fig. 2D. The voltage across the load is now the line voltage as shown in the shaded area of Fig. 2E. From t_4 to t_6, the saturable reactor is unsaturated and the equivalent circuit reverts back to that of Fig. 2C. The voltage on the load is once again sinusoidal and lagging the line voltage. This process is repeated on each succeeding half cycle yielding the basic output waveform shown in Fig. 2G.

To obtain a good basic waveform on a resistive load, the saturable reactor should be designed to fire at 90 deg. The inductive reactance of the linear reactor should be approximately equal to the load resistance.

The efficiency of the first single-phase tripler in the power supply is 70 percent. To improve waveshape, the efficiency of the last stage of the power supply was reduced to 35 percent.

The overall efficiency of the power supply is 21 percent. The output is 25 watts at 40 volts at a fre-

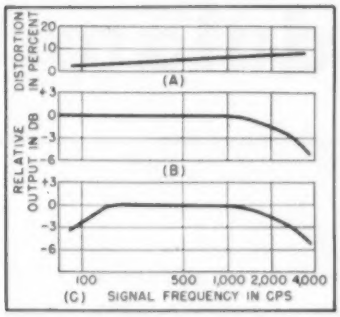


FIG. 5—Amplifier distortion (A) and response (B) with system response (C)

Table II—Reactor Winding for Magnetic Amplifiers

Winding	Wire Size	Turns
N_1	No. 20	130
N_2	No. 20	130, tapped at 50 turns
N_3	No. 20	10

All cores—1⅛ in. × 0.001 Orthonol tape ⅞ in. i-d, 1 in. o-d

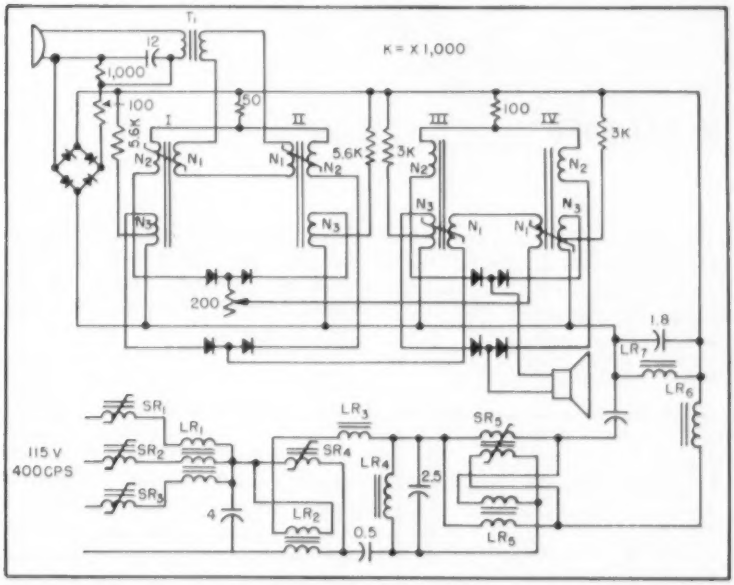


FIG. 6—Circuit of magnetic audio amplifier. Microphone transformer uses same molypermalloydust core as *LR*$_7$ and is wound with 420 turns and 60 turns of No. 23 wire to provide 7-to-1 stepdown

quency of 10,800 cps with harmonic distortion less than 5 percent. An oscillogram of the output waveform is shown in Fig. 3.

Magnetic Amplifier

The magnetic amplifier designed for operation with the high-frequency power supply must have a low power demand since limited power is available. Also, little or no direct-current component must be drawn from the multiplier and the amplifier must have sufficient bandwidth to reproduce satisfactorily audio signals. A two-stage half-wave magnetic amplifier was chosen to meet these requirements. It consists of two saturable reactors per stage, appropriate selenium rectifiers and other static components. The power gain is about 1,000.

The complicated nature of control in the magnetic amplifier causes both frequency and nonlinear distortion under certain conditions. These effects are shown in Fig. 4.

The magnetic amplifier is controlled during some presetting period. In this case this period occurs during alternate half-cycles of the carrier. The portion of the signal that is effective in controlling the amplifier is indicated by the shaded area. Because the bridge-type amplifier is phase reversible, the phase and magnitude of the output on each half-cycle is determined by the phase and magnitude of the effective signal during the control half-cycle.

For signal frequencies below half the carrier frequency, for example 3,600 cps as shown in Fig. 4A, the output is essentially 3,600 cps. At half the carrier frequency, or 5,400 cps, the output is either 5,400 cps as in Fig. 4B, or zero as in Fig. 4C, depending on the phase of the signal with reference to the carrier. For signal frequencies greater than half and less than the carrier frequency, for example 7,200 cps, the output is seen to contain a large component of 3,600 cps (Fig. 4D). This beat frequency between the signal and carrier frequencies is the source of the nonlinear distortion. In addition, for signal frequencies approaching half the carrier frequency, reduced output is obtained depending on the relative phase between the signal and carrier.

The overall frequency and nonlinear distortion of the amplifier working from the frequency multiplier was less than 10 percent over the bandwidth. A plot of distortion versus frequency is shown in Fig. 5A.

The bandwidth of the audio amplifier is zero to 3,000 cps as shown in Fig. 5B.

System Performance

A schematic diagram of the entire audio system is shown in Fig. 6. The input circuit consists of a carbon microphone, transformer and d-c source. The d-c voltage is obtained by rectifying and filtering a portion of the 10,800-cps voltage. Output of the amplifier is fed directly into the voice coil of a permanent-magnet speaker. The bandwidth of the entire system is 90 to 3,000 cps as seen in Fig. 5C.

The physical size of the entire unit can be seen from the photograph. The amplifier and power supply can be packaged in a unit 5 in. × 5 in. × 6 in.

Audio output power is 2.5 watts with less than 10 percent distortion over the frequency range. Since no warmup time is required, the system will operate without standby power and the unit need be excited only when voice amplification is desired. Thus a push-to-talk switch could be the on-off power switch.

Transistor Modulator

SUMMARY —— Germanium diode bridge and three-stage amplifier employing *pnp* junction transistors converts d-c control signal to reversible-phase a-c. Use in flight trainers involves converting analog computer output into signals for autopilot with minimum expenditure of power and space

By GEORGE M. ETTINGER* *English Electric Company, Rugby, England*

CONVERSION of low-level d-c into reversible-phase a-c is accomplished with minimum expenditure of power and a saving of space by the transistor modulator.

Applications include flight simulators where d-c outputs from analog computers are to be translated into a modulated a-c input for autopilot installations. The modulator is characterized by fairly small drift (less than 25 mv in three days) and acceptable linearity (dynamic range between drift level and maximum signal of the order of 30 db). No sharply tuned circuits are employed.

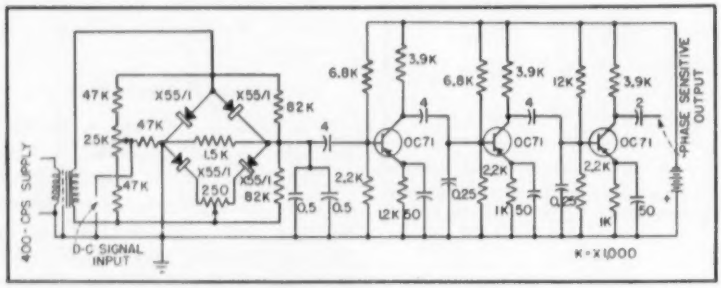


FIG. 1—Modulator uses full-wave germanium diode bridge and three-stage transistor amplifier

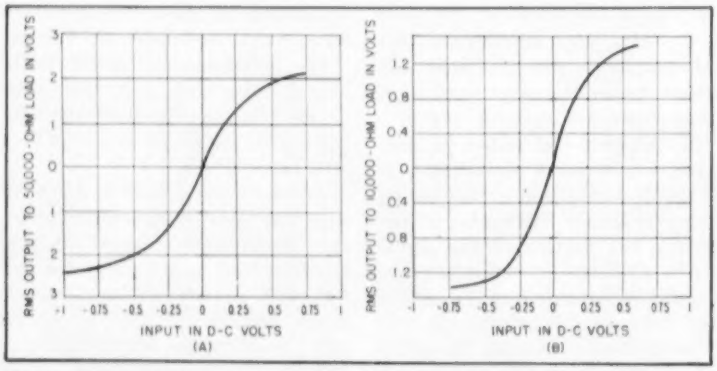


FIG. 2—Transfer characteristics of modulator working into a 50,000-ohm load (A) and 10,000-ohm load (B)

Circuit Details

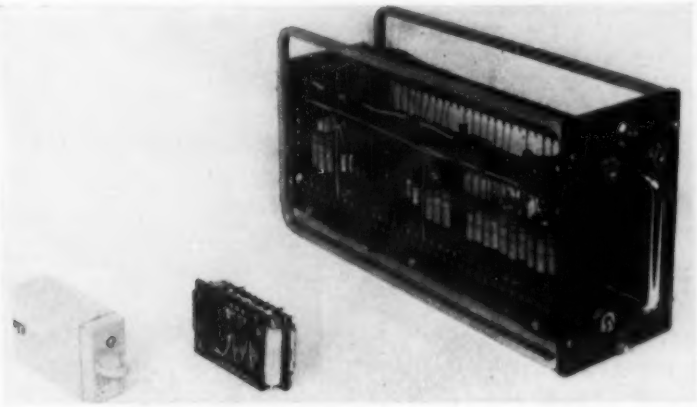
Conversion is effected in a germanium diode bridge modulator circuit which is relatively insensitive to variation of diode parameters since the balance point is determined essentially by the ratio of fixed ohmic resistances rather than by the ratio of diode resistances.

The modulator bridge feeds a three-stage *pnp* junction transistor amplifier using grounded emitter connections. Depending on required amplifier output voltage, the amplifier load may be transformer coupled or R-C coupled.

Figure 1 shows the complete circuit of the instrument. Four GEC type X55/1 high-back-resistance germanium diodes are connected in a bridge. A shielded transformer provides excitation of less than 1 volt at 400 cps although excitation at other frequencies is possible.[1] Balance of the resistance bridge shown shunting the diode bridge of Fig. 1 is adjusted by a 25,000-ohm potentiometer.

* *This work was done at Air Trainers Ltd., Aylesbury, England.*

for Flight Trainers



Two views of transistor modulator (left) and electron-tube unit which it replaces

During the nonconducting half-cycle the d-c input signal is connected in series with the bridge load. When the diodes conduct, the resistance bridge is short-circuited. A 250-ohm potentiometer is provided to balance the rectifier forward resistances. Harmonic currents generated in the absence of d-c input are attenuated by two 0.5-μf capacitors which shunt the bridge load. Where drifts of the order of $\pm$10 mv are acceptable, it is unnecessary to select specially balanced diodes.

Bridge output impedance is chosen to be of the same order of magnitude as the input impedance of the first transistor stage. The impedance could be increased considerably by connecting a large unbypassed resistor in series with the emitter of the first stage.[2] In the present circuit, the amplifier input resistance totals just over 1,000 ohms.

Large emitter bypass capacitors are provided in each amplifying stage. These are necessary not so much to maintain high gain at the operating frequency of 400 cps but rather to minimize phase shift. The manufacturer's rated dissipation of 6 milliwatts for the OC71 junction transistors is not exceeded under any operating conditions, including those where amplifier power supply voltage changes by $\pm$20 percent.

Conversion gain (defined as rms voltage output into a 50,000-ohm transformer-coupled load divided by d-c input voltage from a 20,000-ohm source), is six. Working into a 10,000-ohm R-C coupled load conversion gain is four. Transfer characteristics are shown in Fig. 2.

Drift was equivalent to 12 mv d-c input over a three-hour period and 25 mv over 68 hours. Maximum output of 2 volts rms into 50,000 ohms was obtained for 400 mv input, giving a dynamic range between drift input and full input of the order of 30 db. Limiting occurs in the last transistor stage. Dynamic range measured to the collector of the second transistor is about 45 db.

The modulator is relatively insensitive to changes of excitation voltages. Changes equivalent to $\pm$10-mv input variation are caused by $\pm$10-percent excitation voltage change or $\pm$20-percent excitation frequency change. Conversion gain is substantially unaffected by $\pm$30-percent excitation voltage change, and the transistor amplifier gain varies about $\pm$1 db for $\pm$30-percent change of collector supply voltage. Amplifier power supply is -9 volts d-c at 7 milliamperes.

Phase shift between the secondary of the excitation transformer and the amplifier output is 60 degrees at 400 cps. The phase slope is approximately 0.8 radians per octave at that frequency.

Conclusions

It appears practicable to operate the last transistor stage as a phase sensitive detector for certain servo applications where d-c output is required. To obtain the power necessary to drive servo motors, the transistor amplifier output may be fed to a half-wave bridge magnetic amplifier.[3,4,5]

Drift level of the transistor modulator is higher than that of magnetic amplifiers.[6,7,8] However, in contrast to magnetic amplifiers, the transistor amplifier is relatively insensitive to changes of excitation frequency and has an inherently greater bandwidth.

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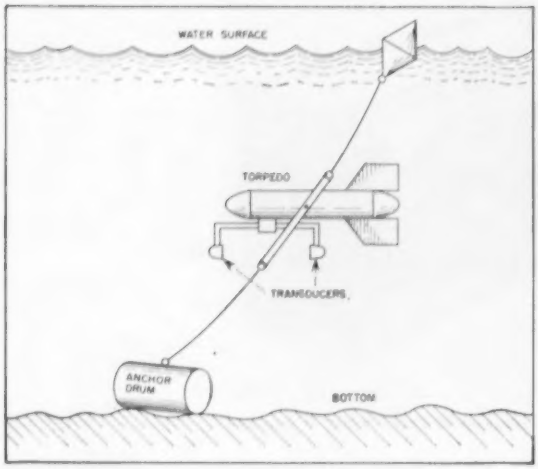
Ultrasonic Phase Meter



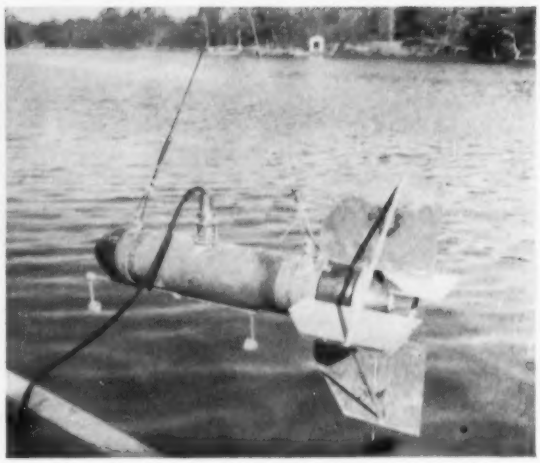


FIG. 1—Arrangement of velocity-measuring equipment under water. Torpedo unit is shown at right prior to immersion. Once every week, anchor drum is raised to surface to service equipment mounted inside

SUMMARY —— Magnitude and direction of subsurface water currents at remote locations are automatically measured and recorded by instrument incorporating phase measurement circuit. Meter indicates phase unambiguously over range of 0 to 360 degrees

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INTENDED for use in marine research, an improved phasemeter circuit has been developed as a part of an instrument for measuring water velocity with ultrasonic waves.[1]

The complete instrument consists of two main units. The transducers are attached to a torpedo-shaped enclosure which contains a phase measuring circuit, magnetic compass and transfer relay. The other unit is a large drum which contains a storage battery, power supplies, control circuits, indicators and recording camera.

Figure 1 shows the arrangement of the equipment in the water. The large drum rests on the bottom and acts as an anchor. One end of a steel cable is attached to the drum and the other end is supported at the surface by a buoy with the torpedo attached at the desired depth of measurement. An 8-conductor cable also runs between the drum and the torpedo. The torpedo is mounted in a gimbal so that it is free to align itself with the current.

Basic Ultrasonic System

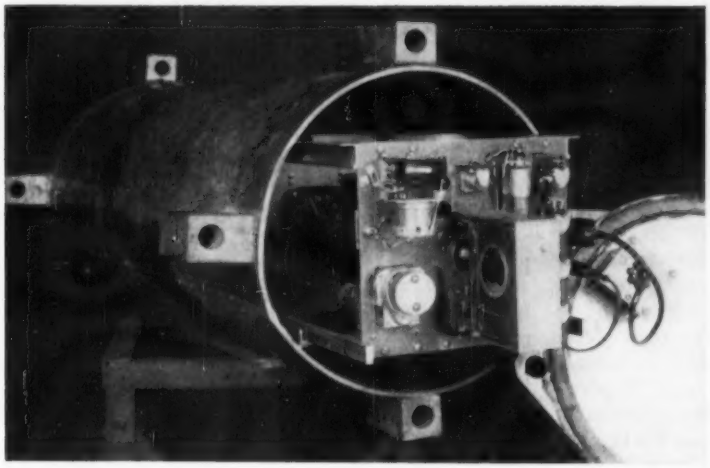
Figure 2 shows two submerged ultrasonic transducers separated by distance D. Transmitter T sends out continuous sine waves to receiver R. The wavelength λ can be expressed as $\lambda = (v + V)/f$ where f is ultrasonic frequency, v is velocity of propagation through still water and V is the component of water velocity in the direction from T to R. Letting N be the number of wavelengths between T and R

$$N = D/\lambda = Df/(v + V) \qquad (1)$$

In practice, D should be at least 1 foot to obtain a sufficient sample of the true water velocity unobstructed by the transducers, f should be greater than 100 kc to permit small transducer size with narrow beam width and $v \cong 5{,}000$ ft per sec; therefore, N must be greater than 20.

If the received signal is compared to the transmitted signal, a phase difference of $2\pi N$ will exist between them, but since most phase meters can only measure angles less than 2π, the measured phase difference will be $2\pi\ (N - n)$ where

Measures Water Velocity



End view of anchor unit shows timers, control circuits, indicating meters and recording camera. Storage battery is at opposite end of drum

n is an integer such that $0 \leqq (N - n) < 1$. This restricts the maximum measurable change in N to unity, if phase ambiguity is to be avoided.

With this instrument it is desired to find V in the range from 0 to 5 ft per sec by measuring phase. Since $N > 20$, small changes in N due to changes in parameters D, f and v will be magnified percentagewise more than 20 times in terms of $(N - n)$.

Variations in temperature, depth and salinity of the water cause changes in v of approximately 0.1 percent per degree F, per 300 ft of depth and per 0.1-percent change in salinity, respectively. Therefore, expected changes in v will completely obscure the desired indication of V. The magnified effect of parameter variations can be eliminated as follows. Normally D, f, v and V vary so slowly that they may be considered as constant for a period of a few seconds. Then, if T and R are reversible and a measurement is made in each direction within a few seconds, all the quantities on the right side of Eq. 1 will have the same value for each direction, but the sign of V will change. This will give a new value, N', of N in the reverse direction

$$N' = Df/(v - V) \qquad (2)$$

Subtracting Eq. 1 from Eq. 2 and letting $N_d = N' - N$

$$N_d = 2VDf/(v^2 - V^2) \qquad (3)$$

Solving Eq. 3 for V and simplifying

$$V \cong KN_d \qquad (4)$$

where $K = v^2/2Df$

If the phase meter has a scale of 0 to 1 corresponding to phase angles of 0 to 2π, then N_d is the difference obtained on subtracting the meter reading with T to R in the direction of V from the reading in the reverse direction or 1 plus this difference, if the difference is negative.

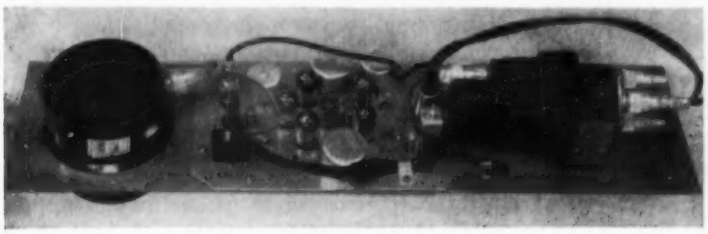
The values chosen for this instrument are $D \cong 1.8$ ft and $f = 1$ mc; therefore, $K \cong 6.95$ ft per sec.

Phase-Meter Circuit

To measure the phase relation of the transmitted and received ultrasonic signals the unit had to be small, consume little power and indicate phase unambiguously from 0 to 360 degrees. A special requirement was that one lead to the indicating meter had to be common with some other necessary lead to reduce the number of wires in a connecting cable. The basic operation of the circuit can be explained in terms of the block diagram of Fig. 3.

The two transducers are connected through a 24-volt motor-driven coaxial transfer switch so that the direction of transmission may be reversed. The 1-mc crystal-controlled transmitting oscillator drives one of the transducers which sends out ultrasonic waves toward the other.

The electrical signal from the receiving transducer is amplified and



At left is remote-indicating magnetic compass, which gives orientation of torpedo and therefore water-current direction. Phase-meter chassis is at center and motor-driven coaxial transfer switch at right. Entire unit mounts in torpedo

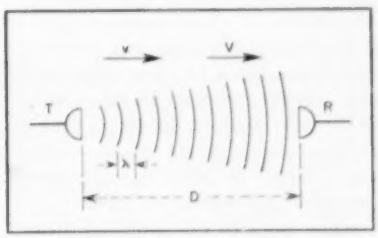


FIG. 2—Ultrasonic-wave path between two submerged transducers. Transmitter T sends continuous sine waves to R

mixed with the signal from a 0.992-mc crystal-controlled heterodyne oscillator. The mixer circuit output is tuned to the difference frequency of 8 kc. A sample of the transmitted signal and the oscillator signal are fed into another similar mixer to obtain another 8-kc signal.

Changes in phase between the 1-mc received and transmitted signals produce the same changes in phase between the two 8-kc signals. These are fed into two identical pulse-forming circuits which produce a short trigger pulse for each cycle of the respective 8-kc sine waves. Phase changes now appear as varying time between trigger pulses in the two channels.

Switching Circuit

A 1-ma constant-current source is turned on by the trigger pulses from one channel and turned off by the trigger pulses from the other. Therefore, the output of the switching circuit will consist of current pulses of 1 ma amplitude, with a length which varies linearly with phase and with a repetition rate of 8 kc. These pulses pass through a 1-ma d-c meter that indicates the average current, which is a linear function of pulse length. Therefore, the full-scale range of the meter represents a 360-degree range of phase between the 1-mc received and transmitted signals.

This circuit is not required to measure the absolute phase relation, but only the changes in phase when the direction of transmission is reversed. Therefore, residual phase shifts in any part of the circuit are not important, even if they vary slowly in respect to time. If the transducers have different phase characteristics when transmitting than when receiving, a fixed phase error will exist at all velocities; however, this error is easily measurable at zero velocity. Therefore, a given water velocity will produce a known difference in meter readings at any time, but the absolute meter readings will drift with respect to time due to changes in residual phase shifts and changes in water temperature, pressure and salinity.

Tube heaters are supplied from a 24-volt battery. Plate-supply voltage is obtained from a dynamotor. The battery voltage may vary from 28 volts to 20 volts under normal operation causing excessive variation in dynamotor output voltage. Since the switching circuit requires a well-regulated voltage, a series-tube regulator is used to stabilize the plate-supply voltage of all the tubes.

Circuit Details

The complete diagram is shown in Fig. 3.

The 1-mc transmitting oscillator, V_{1}, is an electron-coupled Pierce circuit. Its plate is capacitively coupled to one of the quartz transducers through several feet of coaxial cable and the transfer relay.

The total plate-to-ground capacitance is resonated with a slug-tuned inductor to give a high load impedance for maximum driving voltage on the transmitting transducer. Similarly, the receiving transducer is connected to the grid of V_{2} through coaxial cable and the relay, with the circuit capacitance tuned out by an inductor to give parallel resonance for maximum grid voltage.

The transducers are disks of X-cut quartz, $\frac{3}{4}$ inch in diameter, ground for thickness-vibration resonance of 1-mc, with silver electrodes fired on both surfaces. They are mounted in streamlined brass holders with one surface exposed to the water. Radiation beam width is approximately 12 degrees.

An important design problem was to minimize all stray coupling between the 1-mc transmitting and receiving circuits. The phase of the received signal varies with water velocity, but the phase of leakage signals does not vary; therefore, the vector sum of the two signals, which is the voltage applied to the grid of V_{2}, will have a phase error that varies with the phase of the received signal.

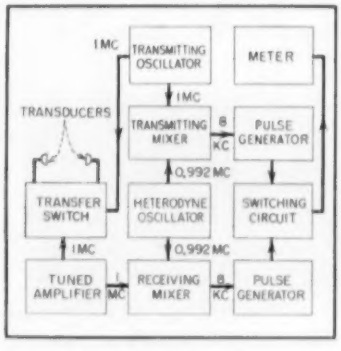


FIG. 3—Phase-meter system

Good shielding and decoupling are required to reduce this error, but the critical point in the circuit is the transfer switch where the transmitting and receiving paths must be in close proximity. Therefore, this switch must be a high-grade coaxial type with very low crosstalk.

Tuned-pentode amplifier V_{2} builds up the received signal for injection into the mixer grid of V_{4}. A sample of the transmitted signal is coupled into the mixer grid of V_{3}. The first three elements of V_{3} and V_{4} are connected in parallel in an electron-coupled Pierce-oscillator circuit operating at 0.992 mc.

The plate circuits of the mixer tubes are tuned to the difference frequency of 8 kc and are directly coupled into multiar circuits[5] made up of V_{5A}, V_{6A} and of V_{5B}, V_{7A} respectively. The multiar circuits regenerate from conduction to cutoff at the exact time the respective 8-kc sine waves from the mixers cross their a-c zero axes (B+ potential) going negative. This produces a sharp-rising-step voltage across the respective plate-load resistors of V_{5A} and V_{7A}. These steps are differentiated to form short positive pulses which are applied to the grids of V_{6B} and V_{7B}.

Cathode follower V_{6B} and plate-output amplifier V_{7B} have their respective cathode and plate tied together and connected to capacitor C as a common load. Both tubes are normally biased just beyond cutoff by a resistance voltage divider from B+. Since these two tubes are the only source of charge for C, except for grid current in V_{6A} and leakage, the voltage across C will remain fixed at the value obtained from its last previous charge so long as V_{6B} and V_{7B} are cut off.

When a positive pulse is applied to the grid of V_{6B}, a short pulse of cathode current flows which charges C and raises the voltage at the grid of V_{6A}. When a positive pulse is applied to the grid of V_{7B}, a short pulse of plate current flows which discharges C and lowers the voltage at the grid of V_{6A}. The maximum

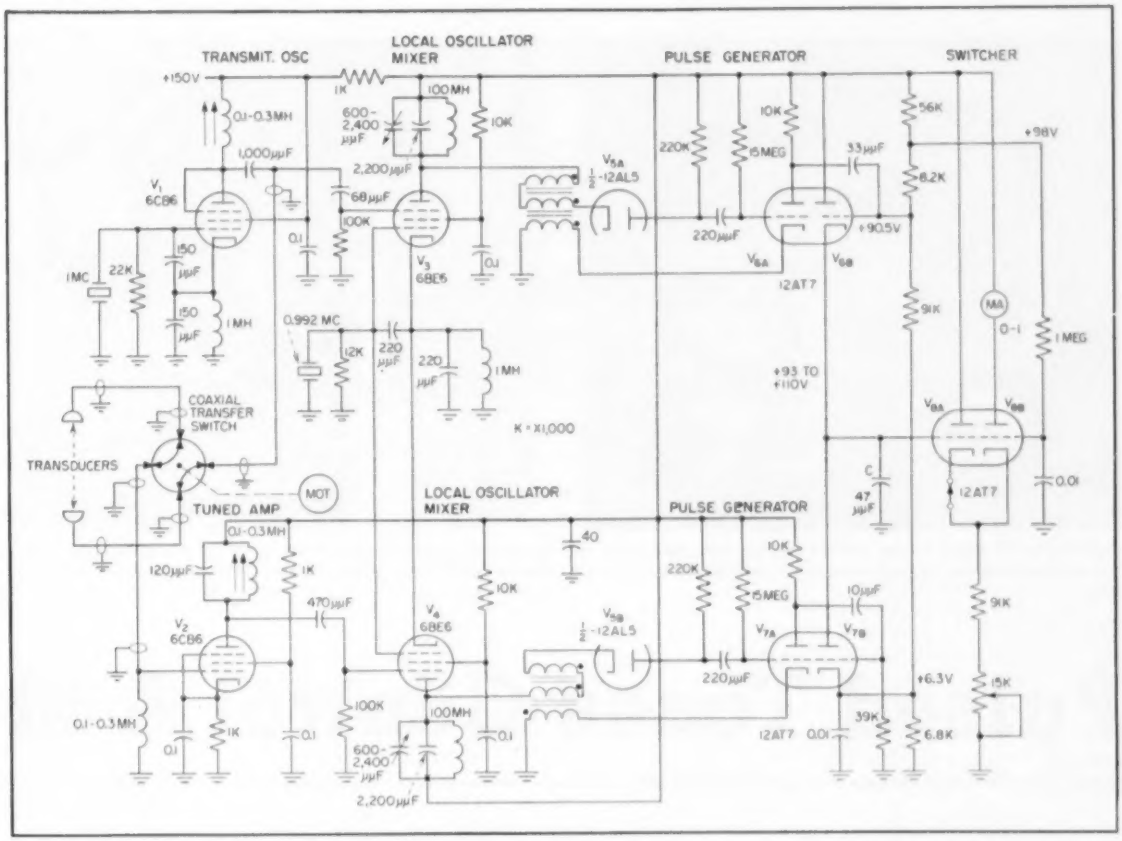


FIG. 4—Critical point of phase-meter is motor-driven transfer switch. Since received and transmitted signals are in close proximity, switch be a high-grade coaxial type and must have low crosstalk

potential across C is limited to approximately 110 volts by the grid current of V_{8A}, while the minimum potential is held above 93 volts by the clamping action of V_{8B}.

The changes in potential at the grid of V_{8A} cause it to act as a switch which controls constant-current tube V_{8B}. When the potential is above 99 volts, V_{8A} draws plate current and raises the potential of the cathodes enough to cut off V_{8B} so that no current flows through the meter. When the potential across C is below 97 volts, V_{8A} is cut off and V_{8B} acts as a constant-current source of 1 ma for the meter. The constant-current operation is obtained by maintaining the grid of V_{8B} at a constant potential of 98 volts so that the current through the tube is determined by the cathode resistance. The circuit is adjusted by breaking the cathode lead of V_{8A} and varying the cathode resistance of V_{8B} to give a full-scale deflection of the meter.

Since the switching action of V_8 is very fast, the current pulses through the meter are rectangular. The meter responds to average current; therefore, the reading will be a linear function of the duty cycle. The duty cycle is controlled by the time relation of the trigger pulses, which in turn is determined by the phase relation between the transmitted and received signals. Therefore, the meter reading will be a linear function of phase, varying from 0 to 1 ma as phase varies from 0 to 360 degrees.

Control Equipment

The control equipment is designed to turn on the instrument once every half-hour for an interval of time only long enough to warm up the tubes and make one set of readings. Under this mode of operation the battery will supply energy for over one week. A small direct current-to-400 cycle rotary converter is used to excite the compass-indicator circuit.

An 8-mm movie camera with its shutter removed and its mechanism modified for single-frame film advance is mounted to photograph the phase meter, the compass indicator, an indicator showing the transmit-to-receive direction and an 8-day clock. The exposures are made by flashing a small lamp.

This instrument was designed and constructed by the Department of Electrical Engineering in cooperation with the Chesapeake Bay Institute of the Johns Hopkins University for The Office of Naval Research

The author appreciates the cooperation of those people at the university who helped in the development of this circuit.

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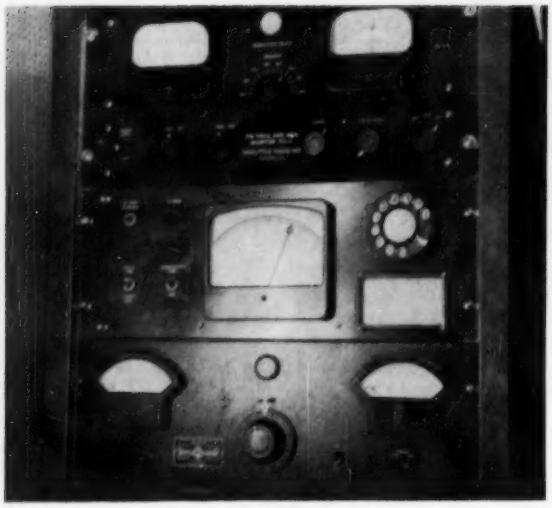
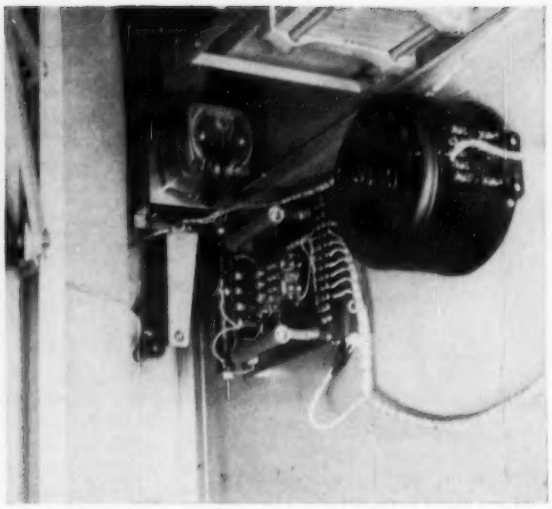


Control point at studio selects desired function with dial impulses (center right) and meters read telemetered information from transmitter



Typical motorized control added to 10-kw f-m transmitter makes remote tuning from studio possible. Plate current metering shunt is below motor

Pulsed Tones Control A-M

SUMMARY —— Complete remote operation of two broadcast transmitters over a two-wire line includes functions of alarm, metering and control. Audio tones of 1,000; 2,100; 2,200; 2,300 and 2,600 cycles used in conjunction with telemetering and pulse-counter equipment permit tuning from studio six miles distant

By HERBERT MICHELS

Chief Engineer
Radio Station WHCU
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INSTALLATION of a broadcast remote control system has been completed recently at WHCU whereby complete control of a 1,000-watt a-m transmitter and a 10,000-watt f-m transmitter atop Mt. Pleasant is achieved from the studio-control point in downtown Ithaca, six miles distant.

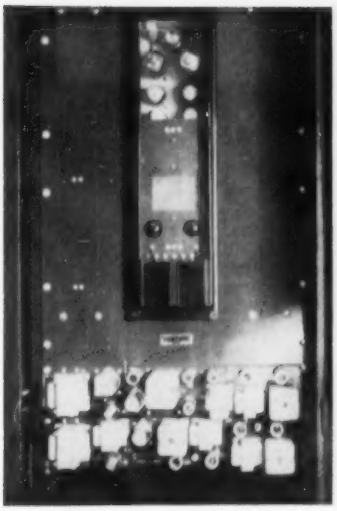
In determining the basic method of remote-control for the transmitters several conditions peculiar to the existing installation had to be considered. These include the availability, reliability and cost of telephone-line circuits and the possibility of future microwave interconnection between the studio and transmitter sites. Also considered were the expansion possibilities of the relative systems as well as equipment reliability and long-term operating costs.

Two-Wire Line

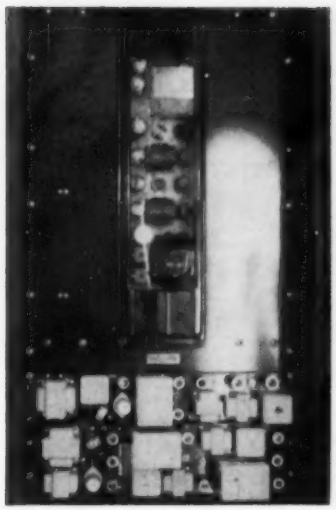
In the system used, all control and metering information is carried over a single audio transmission circuit as indicated in Fig. 1. Control information is sent from the control point to the transmitters in the form of three fixed-frequency keyed audio signals. Returning metering information is also carried over the same control channel in the form of a fixed-frequency keyed audio signal.

The various control and metering frequencies are shown on the block diagram. Selection of these frequencies was determined by the type of audio transmission circuit available and optimum tone-generator and tone-receiver performance. Harmonic and beat-frequency interference were also considered.

In any broadcast remote-control system, transmitter control and metering circuit selection is a basic requirement. It is accomplished in the system at WHCU by a telephone-dial pulse generator at the control point and a stepping-relay pulse-counting unit at the trans-



Studio equipment for remote control includes telemetering receiver, duplex signaling unit and dual transmitter



Transmitter equipment employs telemeter device to send back voltage or current values.

and F-M Stations

mitter. Pulses are sent from the control point to the transmitter site as 2,300-cps interrupted tone.

The basic tone-generator circuit is shown in the lower part of Fig. 2; this is a section of the Hammarlund duplex signaling unit. The oscillator cathode is keyed to ground by the telephone dial. Oscillator frequency is adjusted by variable inductor L_1; second harmonic suppression is achieved by the push-pull oscillator circuit arrangement and circuit balancing control R_1.

Audio signal output is capacitance coupled to the grids of buffer amplifier V_6. The plate circuit of V_6 is connected to feed the telephone line through the line bridging transformer and attenuator network.

Output bridging is required, since other circuits are also connected to the same telephone line to achieve the full complement of control and metering facilities.

At the transmitter site, the 2,300-cps tone is accepted by the receiver section of a signaling unit. The signal is first amplified by V_1 (Fig. 2) to a level sufficient for presentation to the band-pass filter. The filter employs a triple-tuned circuit arrangement using three high-Q toroidal inductors. A design requirement of this filter is a minimum of 35-db attenuation to the adjacent channel, separated 100 cycles.

A second amplifier V_2 restores the filter-attenuated signal-voltage level and provides sufficient output to feed V_3 the signal rectifier. The positive rectified and filtered voltage is applied to the grid of relay tube V_4.

Relay K_{11}, its coil in series with the plate voltage supply of V_4, will energize as a rectified positive voltage is supplied from the signal rectifier. Contacts on K_1 provide pulses, corresponding to those generated by the studio telephone dial, to a pulse-counting unit.

Dialing System Operation

The pulse counting unit in Fig. 3 is basically a stepping relay K_{13} with associated slow release relays K_{11} and K_{12}. The relay operation is sequential. With the first dialing pulse K_{11} energizes through contacts of the receiver relay. Relay K_{12} and the rotor coil of K_{13} energize on the first pulse space through contacts of K_{11} and the receiver relay; K_{13} advances one step.

After the first space is completed, K_{11} and K_{12} are still energized (since they are slow-release relays) and each succeeding pulse space ad-

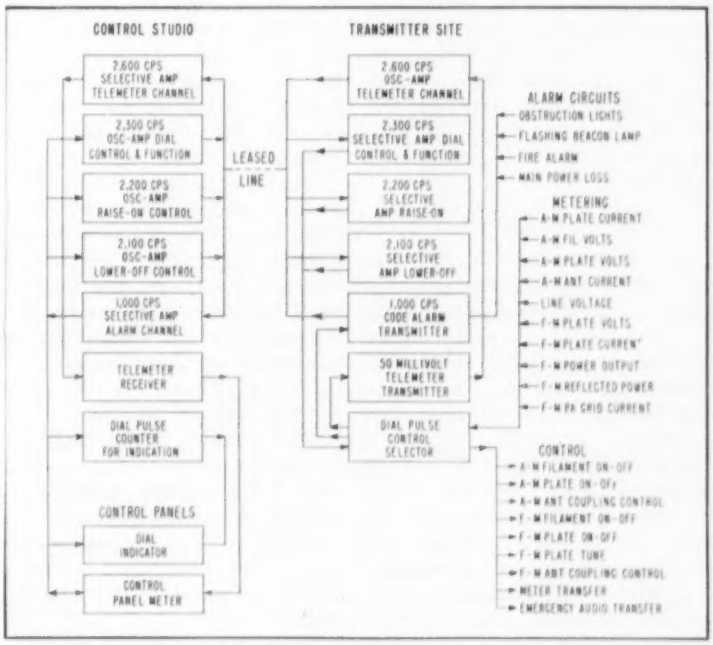


FIG. 1—Operation of remote-control system is illustrated by block diagram

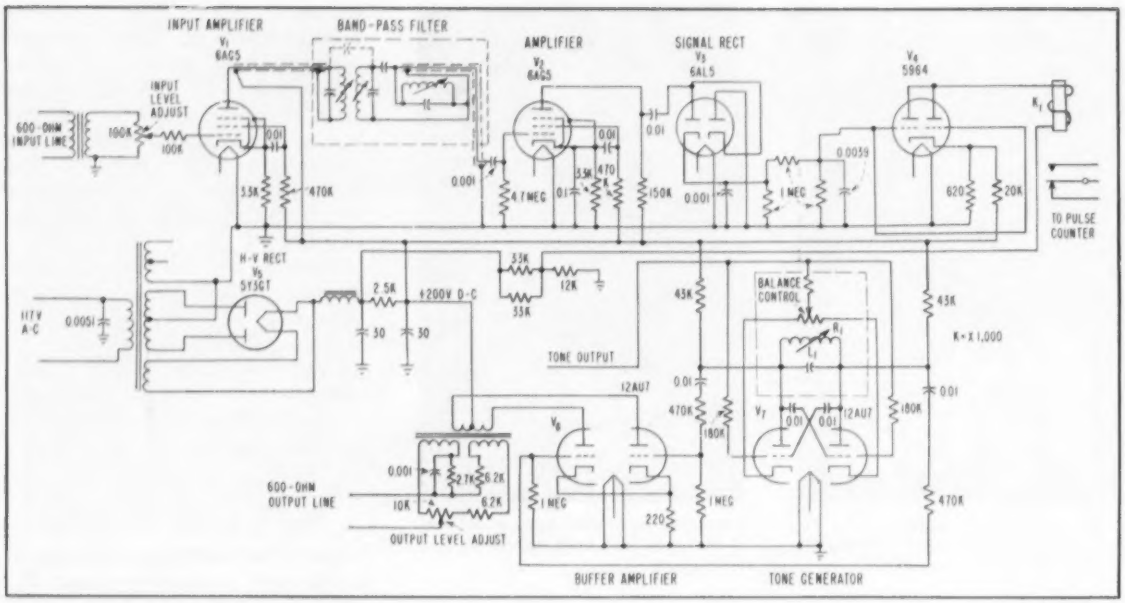


FIG. 2—Tone signaling generator and associated circuits below and receiver above. Band-pass filter component values are chosen for operating frequency permitting common circuitry for all channels

vances K_{12} one step. With the last space (sustained) K_{11} first de-energizes, (K_{12} is held energized somewhat longer by RC circuit R_4 and C_2) and thereby connects the contact arm of K_{12} to ground through R_5 and contacts of the receiver relay. The K_{12} wiper arm energizes the selected control relay (K_2-K_{10}). Next K_{12} de-energizes, which connects power to the K_{12} release coil (through the K_{12} off-normal contacts, contacts on K_{12}, contacts on K_{11} and contacts on the receiver relay). The wiper arm of the stepper, K_{12}, then returns to zero and is ready for the next dialing operation.

Control Relays

Each control relay (K_2-K_{10}) has two sets of holding contacts connected in a series arrangement with all of the other control relays; therefore, as each control relay becomes energized by K_{12}, the previously energized control relay de-energizes.

In addition to the two sets of holding contacts on the control relays, there are three other sets of relay contacts utilized. These connect the desired metering voltage, or current to the telemetering system for transmission back to the control point and connect the RAISE (or ON) control function to the desired transmitter circuit for control. They likewise connect the LOWER (or OFF) control function to the desired transmitter circuit for control.

The method of obtaining remote RAISE-LOWER control is similar to the described circuit-selection method. Basically, a spring-return key switch at the control point controls the ON-OFF condition of two tone generators. Suitable tone receivers at the transmitter site provide a completed d-c circuit path through the dial-selected control relay to the circuit under control.

Referring to the basic block diagram, when the RAISE-LOWER key is pressed to RAISE, the 2,200-cps tone generator is turned on and the tone is transmitted over the telephone line. When the RAISE-LOWER key is depressed to the LOWER position, the 2,100 cps tone generator is turned on. The LOWER control signal is thereby transmitted.

The circuitry of the RAISE and LOWER tone generators is similar to that of the generator provided for the dial-circuit selection system illustrated in Fig. 2; however, instead of a telephone-type dial, a simple spring-return key switch is used.

At the transmitter site, the RAISE and LOWER tone signals are received by means of circuits identical to those in the tone receiver.

Telemetering System

In planning the WHCU system, it was decided to provide continuous metering. For instance, changes in the metered values at the transmitter are immediately indicated at the control point without appreciable time delay. By contrast, in a sampling system a 5-second delay would be encountered.

This provision was primarily incorporated to permit remote motor tuning of the f-m power-amplifier plate and output coupling circuits during winter antenna-icing conditions. The telemetering method selected is also completely independent of day-to-day changes in control line characteristics as well as tube aging.

Basically, the telemetering system comprises a Westinghouse IT-1 telemetering transmitter. This device linearly converts an input voltage between 0 to 25 millivolts into a train of square waves with a frequency rate between 15 and 35 cycles depending upon the input voltage applied. These square waves then control the ON-OFF condition of a 2,600-cps tone generator. The result is a 2,600-cps tone, keyed on

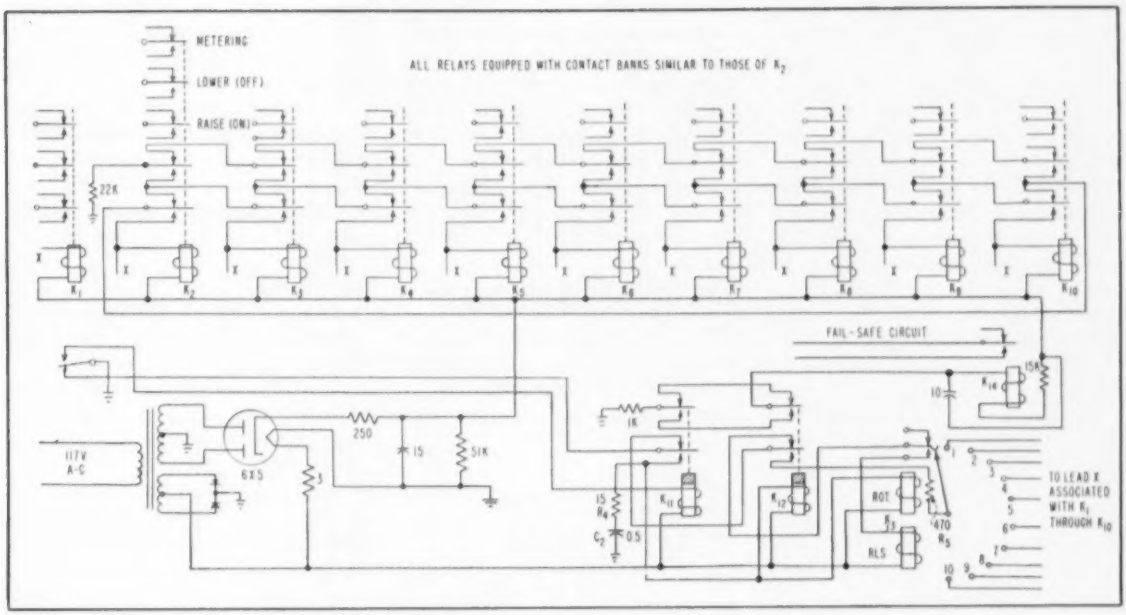


FIG. 3—Pulse-counting unit operates from tone receiver relay and depends upon stepping switch to select proper multibank relay. The relay chosen locks up while the stepping selector returns to normal

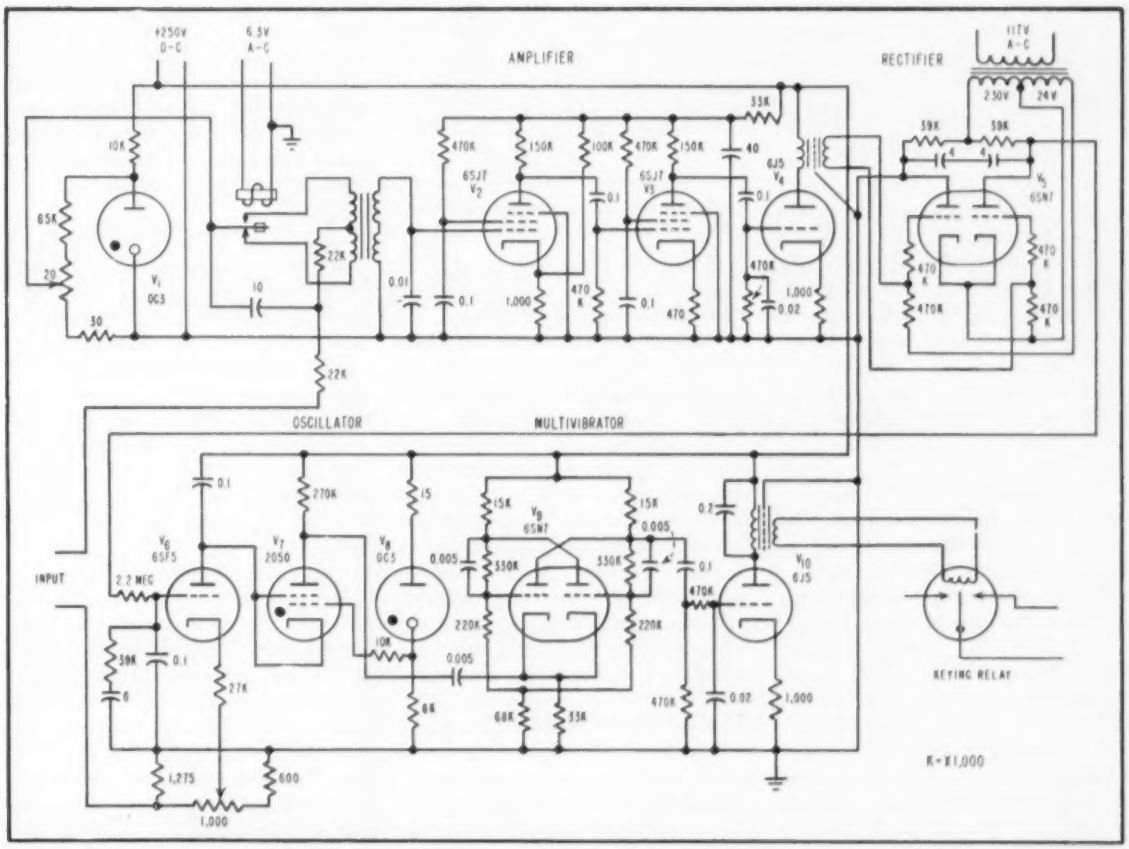


FIG. 4—Modified Westinghouse telemetering transmitter translates meter readings to pulses that are then used to key an appropriate tone. Resultant signals received at control point indicate conditions at radio transmitter

and off at a repetition rate corresponding to the voltage being telemetered.

The telemetering transmitter shown in Fig. 4 performs the following functions. Metering voltage is applied to the input terminals. This voltage is first converted by chopper into a 60-cycle voltage and amplified by a three-stage amplifier V_2, V_3, V_4. The amplifier output is utilized to control d-c bias voltage supply stage V_5. This controlled bias voltage determines the frequency of relaxation oscillators V_6 and V_7.

Multivibrator V_9 divides the 30-70-cps oscillator frequency to the 15-35 cps range. Output from amplifier V_{10} is applied to the coil of the ouput keying relay. Thus, an input voltage applied to the telemetering transmitter input terminals results in an increase in output square wave frequency.

The 15 to 35-cps output, while in itself containing the metering information, is not in a form convenient for reliable transmission over a telephone circuit. The square-wave output of the transmitter is therefore connected to key on and off a 2,600 cps subcarrier generator.

Subcarrier Generator

The 2,600-cps telemetering subcarrier generator is similar to the typical control-circuit tone generator. The telemetering subcarrier is applied to the same telephone line circuit carrying the control signals. Highly selective filters are employed in the control-circuit tone receivers, which provide more than 50-db rejection to the nearest channel.

No interference is encountered even though there is a 30-db signal-level differential between the outgoing 2,600 cps telemetering subcarrier and the line-attenuated incoming 2,100 to 2,300 cps signals.

At the control point, a highly selective subcarrier receiver, similar to that of Fig. 2, is employed; the output 15 to 35-cps square waves are applied to the input terminals of a telemetering receiver.

A telemetering receiver, shown in simplified form in Fig. 5, converts the 15 to 35-cps input into a direct-current output. This is accomplished by a capacitor-charging arrangement wherein the average direct charging current of two capacitors is indicated on a d-c meter.

Two capacitors, C_1 and C_2, are connected so that when V_1 draws current, C_1 will start to charge and when V_2 draws current, C_2 will likewise begin to charge. Tube V_3 is connected so that when it operates, C_1 will discharge and similarly, when V_4 operates, C_2 will be discharged.

The input 15 to 35-cps signal is applied to control grids of V_3, V_2, V_3 and V_4, which are biased to cutoff. When V_1 receives a positive signal on its grid, C_1 starts to charge. When the input signal swings negative, charging of C_1 stops and V_2, its grid connected out of phase with V_1, conducts heavily causing C_1 to discharge rapidly to zero. The action of C_2, V_3, V_4 is similar and occurs on alternate half cycles.

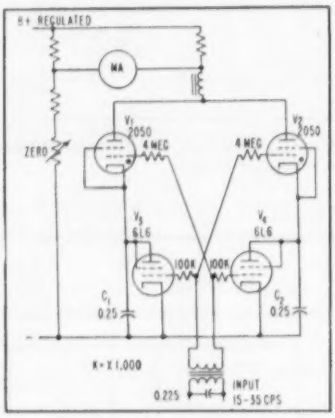


FIG. 5—Simplified telemetering receiver gives direct meter reading

The total average charging current to the capacitors increases linearly as the number of charges per second increase. Hence, the metering information transmitted as an audio frequency is read as a d-c value on the milliammeter in series with the capacitor charging supply.

Since 15 cps represents zero indication on the meter (35 cps represents full scale) some capacitor charging current will exist for a zero indication and a suppressed spring meter would normally be required. However, a d-c bridge circuit is employed to balance out the current to the meter so zero voltage is applied to the meter when a 15-cps signal is received by the telemetering receiver. This permits the use of a conventional type meter.

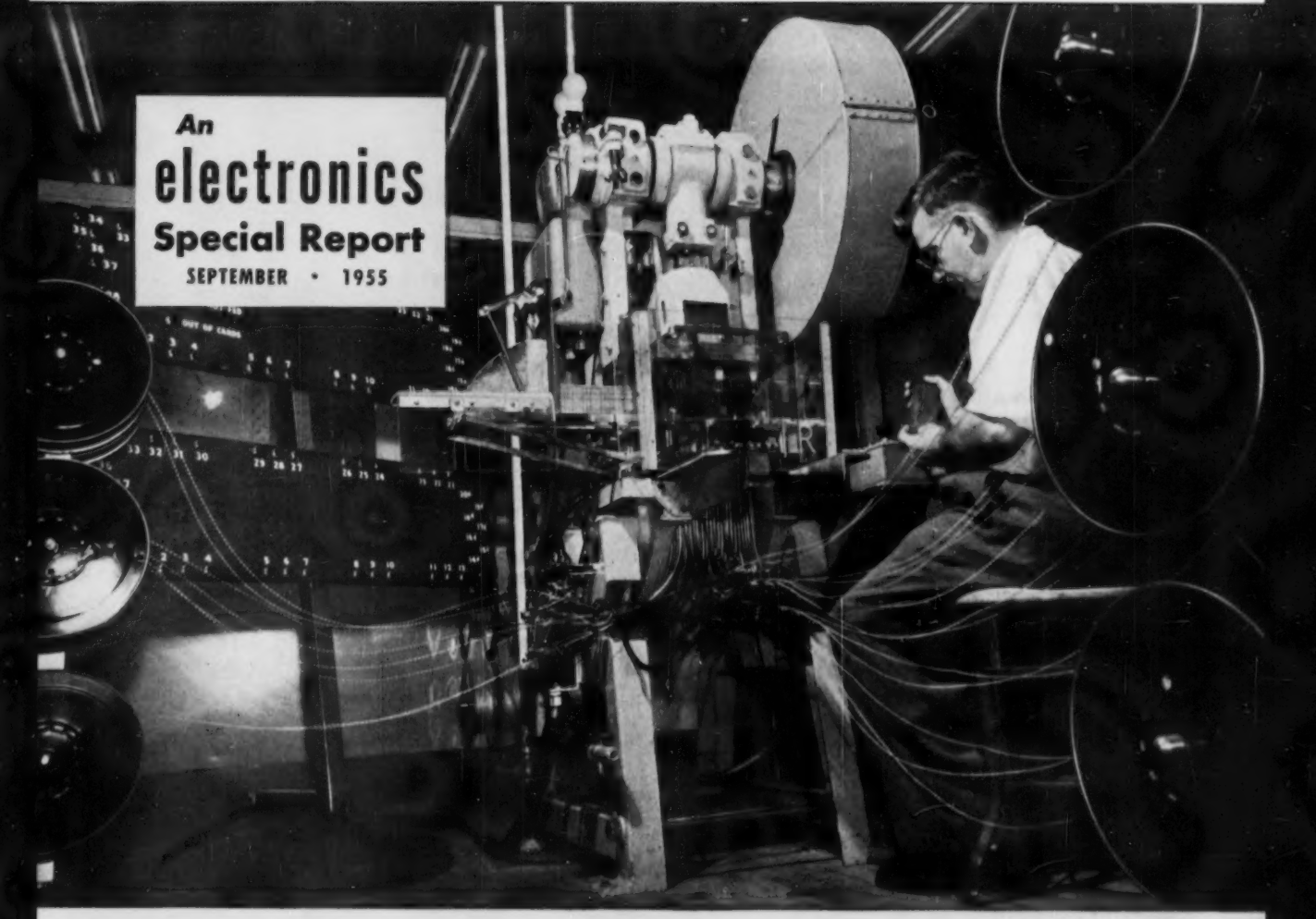
Of prime importance in selecting a method of remote control, were the system expansion possibilities. Future planning at WHCU may include additional equipment to be remotely controlled at the present a-m/f-m transmitter site. Therefore it was important to select a basic system that could be expanded in control and metering functions without incurring excessive expense in control equipment or requiring more than the single leased telephone circuit presently employed for control.

With the system in use, a total of nine basic control positions is available; each position has one metering circuit and two control circuits. Dial position 1 is employed for alarm reset. To expand the present system for 18 full positions of metering and control, the addition of one tone generator at the control point and one tone receiver and one pulse counting unit at the transmitter site would be required. The additional equipment may be added without taking the existing control system out of service for more than a few hours and no additional line facilities will be required.

Fail-Safe Provision

An FCC requirement in all remote-control installations of broadcast transmitters is that the equipment be entirely fail-safe. In other words, should any abnormal condition develop with the remote control system in which control of the transmitters is lost, the transmitters must shut down automatically. This feature is provided by relay K_{14} in the pulse counting unit (Fig. 3).

The fail-safe relay is normally held energized by the continuous 2,300-cps dialing tone sent from the control point. A time delay is incorporated in the coil circuit so that short dialing pulses will not de-energize K_{14}. However, an interruption of the 2,300-cps tone of more than 1 second will permit the relay to de-energize. Contacts are connected to energize the plate-off relays in the transmitters under control.



An electronics Special Report
SEPTEMBER • 1955

MECHANIZED PRODUCTION
of Electronic Equipment

By JOHN MARKUS
Associate Editor

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1. ETCHED WIRING

Mechanization begins with mechanized wiring. Today this is etched wiring, but there are indications that plated wiring is coming up fast. In producing etched wiring boards, new techniques speed up drafting and new machines serve for photographing and etching

MECHANIZATION of electronic production facilities is something to be taken in logical steps rather than all at once.

The first step is mechanization of the wiring process, generally achieved by product redesign for use of etched or plated wiring and manual dip soldering. This is the biggest step, and therefore gives the greatest gains in terms of improved product reliability and lower production costs. Etched wiring is thus the logical subject for the first section of this survey of the status of mechanization in the electronic industry. Before going into etched wiring in detail, however, a preview of the remaining sections of the article will be given for orientation.

Etched wiring calls for terminations that are all at the same end of a component. Since the commonest components have axial leads, this necessitates preliminary cutting and forming of leads in most cases. The use of machines for component preparation is therefore the second step in going to mechanized production.

The logical substitute for hand insertion of components in etched wiring boards is the use of machines for such assembly work. This, then, is the big third step in mechanizing an electronic production line.

The next two logical steps go together—the use of machines to prepare components for automatic handling, and the use of machines to assemble the components on the wiring boards. There are many interim steps involving various combinations of manual and automatic assembly, many of which are even more ingenious than the huge assembly machines themselves.

Automatic dip soldering comes fourth, to take the output of an assembly machine directly without human handling. Some firms have chosen to jump directly to this from etched wiring and use manual loading while exploring the economics of steps 2 and 3.

Last is automatic testing, independent of all the others and yet equally capable of cutting production costs.

These five steps are covered separately as the major sections of this report. Together they give a stop-action picture of an industry that is going ahead fast on the road to mechanization. Individually the sections show what is going on in representative plants of all sizes and types. As in any industry in transition, the individuality of thinking among engineers is everywhere evident.

DEFINITIONS

printed wiring General term for a wiring pattern reproduced on a wiring board by any process, to provide point-to-point electrical connections or shielding. These reproduction processes are usually etching or electroplating rather than true printing.

printed component A component formed directly on a wiring board, such as a printed inductor, resistor or capacitor.

wiring board An insulating board having printed wiring.

printed circuit General term for a combination of printed wiring and printed or conventional components on a wiring board, providing one or more complete paths for electric current.

etched wiring A type of printed wiring formed by chemical removal of unwanted metal from a clad laminate serving as a wiring board.

plated wiring A type of printed wiring formed by electroplating the desired pattern of printed wiring onto an insulating base.

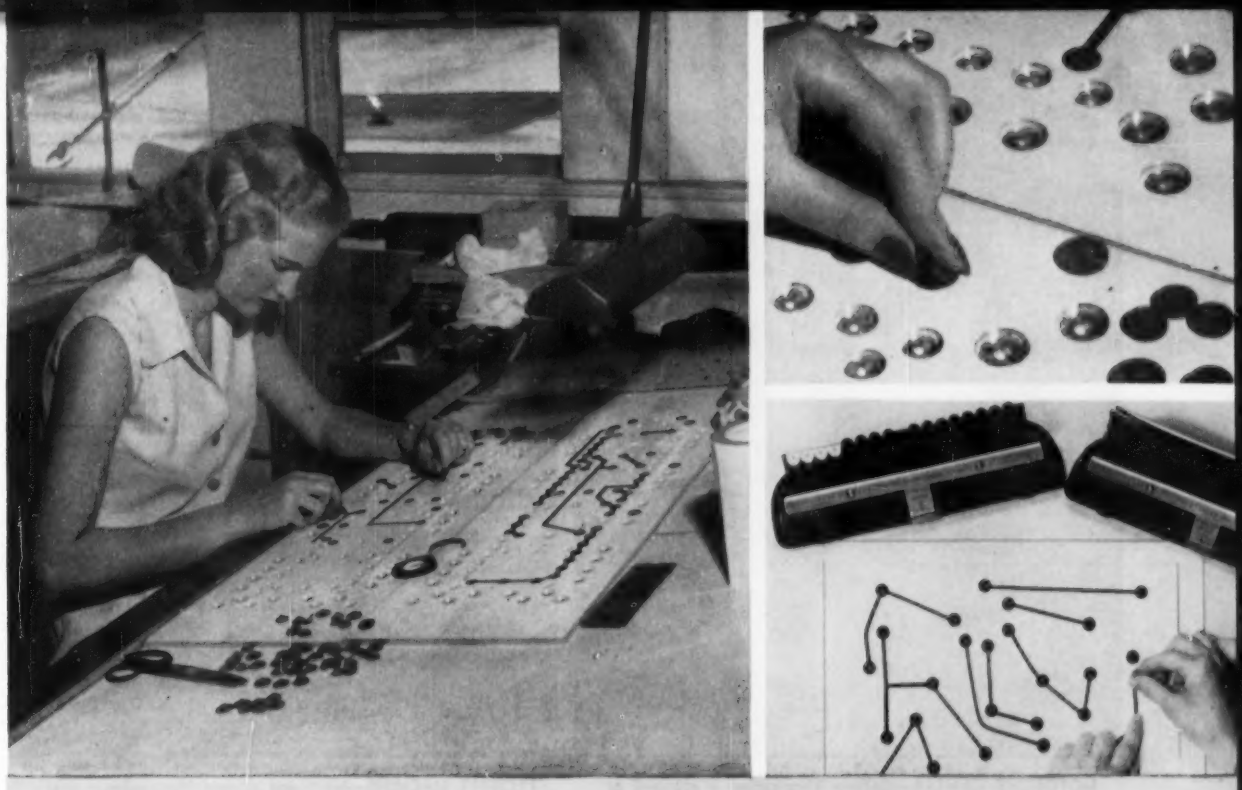
assembly machine A machine used for inserting components in wiring boards.

in-line assembly machine An assembly machine in which insertion heads arranged in a line each insert one component as a wiring board is moved from station to station by a conveyor or other transport mechanism.

single-station assembly machine An assembly machine in which all insertion of components is done at a single station, to which boards are fed or through which boards are circulated.

station The location on an assembly machine at which a wiring board is stopped for insertion of one or more parts.

insertion head The mechanism used at a station to insert a component in a wiring board. This generally includes an automatic feed mechanism, along with cutting, forming and clinching tools in the case of axial-lead components. On some assembly machines, a station may have two or more insertion heads.



MECHANIZED DRAFTING—No ink is used. Narrow black masking tape, available in rolls or strips, serves for wiring and black disks for terminal circles. At Photocircuits, aluminum sheet has holes at all possible terminal positions on IBM radar computer boards, for covering with white tape or filling with black plastic disks as required. Brady disks at lower right are used on drawing paper

Machine assembly on etched wiring boards inherently leads to standardization of board sizes and positions of punched holes. This in turn permits mechanization of drafting procedures.

Mechanized Drafting. Photocircuits Corp. uses masking tape and black plastic disks with a white aluminum sheet to produce four-times-size master drawings for standardized radar computer boards used by IBM. At each possible terminal position, holes are drilled halfway through the aluminum for the disks. To prepare a master drawing, 0.18-inch-wide black masking tape is run between the desired black holes on the board, and unwanted holes are covered with white masking tape.

With drawing paper or glass cloth, self-sticking black terminal circles and connector strips made by W. H. Brady Co. can be used in place of ink. The disks come in a variety of sizes and have a white inner hole for centering. Strips come in $\frac{1}{16}$ and $\frac{1}{8}$-inch widths to give a choice of reduction ratios and etched wiring widths. The strips can be pressed in place either straight or curved.

Less mechanized but equally time saving is IBM's drafting technique involving transparent overlays. Here a twice-size master drawing contains solid black circles at all possible hole locations. The required circuit lines are drawn with pen and ink on a transparent overlay, and the combination is photographed. Undesired holes are then opaqued out on the resulting negative.

Motorized Copying Camera. Uniform illumination of large master drawings on a copying camera is achieved at Photocircuits by mounting two fluorescent lamps vertically on a carriage that is moved across the camera field by an electric motor. The lamps are spaced about 6 inches apart and are completely masked with black on the side facing the camera, except for the vertical slit between the lamps. The camera sees the drawing only through this slit, so that the negative is exposed panoramically from one end to the other as the light source moves across the copy mounted on the vertical board.

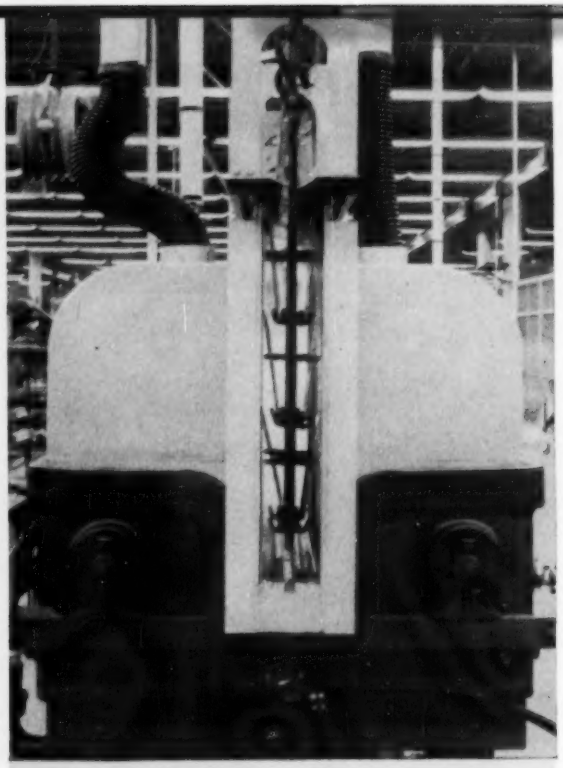
Printing the Resist. The final-size negative is used directly to photoprint the acid-resisting pattern when runs are short and where extreme precision is required, as when printing multi-turn coils directly on the wiring board.

More commonly the negative is used to make a silk-screen pattern, generally on 200-mesh stainless steel rather than silk. This in turn is used in a printing frame to place on the copper-clad phenolic laminate a heavy deposit of acid-resisting ink in the desired wiring pattern, free of pinholes. Screen printing is most economical for long runs, and will reproduce reasonably fine lines adequately.

In most plants screen printing is done conventionally in manual setups wherein the operator lifts the hinged screen to insert a board, then lowers the screen and moves the ink-bearing squeegee across. Emerson and Radio Receptor have semi-automatic machines that are manually loaded but have air cylinders to bring the board up to the screen and move the squeegee across. Others use air cylinders to move the screen up and down.

Use of the negative to make an offset printing plate for applying the resist on a printing press shows promise. Sev-

MOTORIZED CAMERA—Uniform illumination is obtained at Photocircuits by moving vertical fluorescent lamps during exposure, with camera seeing drawing through slit between lamps



ETCHING MACHINE—Input end of new Westinghouse machine which gives automatic etching and rinsing of wiring boards as they are moved through by carrier frame on conveyor

eral manufacturers actually have such presses in their plants for experimentation. The chief problem is getting a sufficiently thick layer of acid-resisting ink on the boards. Some insist that two impressions would be needed to achieve this, while others hope to achieve buildup by dusting the first impression with powdered asphalt and then fusing.

Drying Machines. Baking of the resist is achieved automatically in many plants simply by running a conveyor belt over the top of a long table, with a Calrod or infrared-lamp oven straddling a part of the belt. At Methode Mfg. Corp., this setup is used to dry finished boards after they have been sprayed with a protective coating to prevent oxidation of the etched copper.

Etching Machines. A mechanized etching machine for wiring boards has just been placed in operation by Westinghouse. After the resist is screen-printed on sheets of four boards, the sheets are set into metal carriers that hang from a rotating-spiral overhead conveyor line. This advances the boards at a uniform slow speed through the etch and rinse compartments of the machine.

In the etching chamber, motor-driven rotating paddles below the boards on both sides throw up the ferric chloride etchant in a fine spray that gives fast and uniform etching. The conveyor speed is adjusted as required to give complete etching without undercutting.

After etching, the boards pass between spray rinse jets, then emerge for air drying before unloading. The resist is removed later in a vapor degreaser.

RCA expects to have an automatic etching machine in operation this summer. The boards will be immersed for a constant time interval in a solution of ferric chloride that is kept in violent agitation by powerful pumps in the tanks. The amount of solvent used with the ferric chloride will serve as the variable for controlling the etching process.

Tinned Etched Wiring. An alternate method of producing an etched wiring board involves applying the resist in the reverse of the desired pattern, plating the exposed copper with solder, then removing the resist and etching out the newly exposed copper with an etchant that does not attack the solder. The resulting tinned wiring gives better dip soldering, though at higher cost.

When plated-through holes for leads are required, holes are drilled or punched beforehand and the inside surfaces of the holes are coated with conducting material. Solder then plates in the holes as well as on the wiring.

Plated Wiring. Several firms deposit all wiring by electroplating. Chief problem to date is that of getting good adhesion to the phenolic. Research now under way shows promise of solving this. Since no copper is wasted during plating, the technique may well supersede etching some day. As yet there is no economical way to recover the etched-out copper.

One firm is reported to be using an almost entirely automatic plating machine that starts with punched boards. The surface of the board is cleaned and roughened, a coating of colloidal graphite is applied, the resist is screen-printed over this, 1 to 3 mils of copper is plated over the graphite to form the desired wiring pattern, and the resist and coating are then washed off by the machine.

2. COMPONENT PREPARATION

Mechanized wiring calls for a new look in components, with all terminals or leads suitable for manual or automatic plug-in assembly on etched boards. New machines here do the preliminary punching or drilling of boards, lead cutting, magazine loading and belting

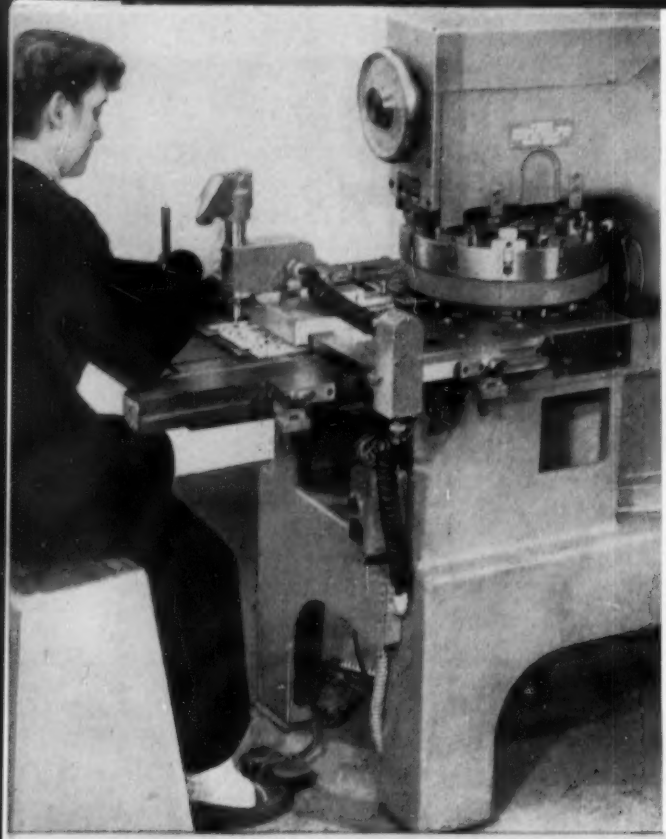
Many different sizes of holes must be punched or drilled in wiring boards before assembly can begin, to accommodate leads, terminals and plug-in components.

One-Shot Presses. For large runs of radio and tv boards, huge presses are used to punch all the holes at once after preheating the phenolic to prevent cracking. Even with manual handling of boards, Methode achieves an average rate of 500 pieces per hour in punching etched boards with one-shot compound perforating and blanking dies on such a press. With this high production rate, the complexities of automatic feed offer little attraction at present.

Board Sizes. Several small wiring boards are generally preferable to one large board in a tv set. As board size increases and the number of holes goes up, it becomes more and more difficult to strip the XXXP phenolic punched board off one-shot dies without breakage. Second, errors in registration due to the need for heating before punching are less serious on small boards. Thus, in current tv chassis designs, Westinghouse has two boards, Admiral three and RCA five.

Hole Sizes. There is little agreement as to optimum hole sizes for leads in etched wiring. The tightest fit currently

PUNCHING MACHINE—Etched boards, in long strips, are locked in holder of pantograph device that moves as operator guides stylus through track in phenolic template. Punch is triggered automatically each time the stylus drops into a template hole and makes contact with metal table underneath. Built by Stromberg-Carlson, setup gives up to 120 holes per minute. Punched-tape control is now being built



PUNCHING MACHINE—Wiedemann turret punch press for etched wiring boards also uses control stylus and template, but gives choice of hole sizes for sockets and other parts as well as leads

DRILLING MACHINE—DuMont's stylus-template-pantograph arrangement drills up to 75 holes a minute, using a compressed-air motor and air feed. Etched boards can be up to 16 x 18 in.

used is a 0.039-inch hole for the 0.032-inch wire used on resistors and jumpers. For this same wire, others will go up to 0.060 or even 0.070 for the hole. The larger the hole with relation to the lead, the easier it is to insert manually and the more reliable is automatic insertion.

A complete rollover clinch permits larger holes because the end of the lead bites into the etched wiring, giving a good soldered connection there even though the solder bead does not fill the hole. In contrast, Westinghouse uses a fairly large hole with no clinch whatsoever and achieves excellent dip-soldering results. Smaller hole diameters invariably minimize dip soldering troubles.

Template-Guided Punch. For short runs of etched wiring boards, Stromberg-Carlson is punching holes one at a time at a production rate of up to 120 holes per minute. The operator merely places the board in a holding device and then moves a stylus through a track in a master template. Each time the stylus reaches a hole in this track corresponding to the location of a hole in the finished piece, the stylus drops in and triggers the punch. The stylus is then automatically retracted so that it can be moved on to the next position. The punching sequence take only a fraction of a second, so that there is no noticeable pause at the holes as the operator moves the stylus along the groove.

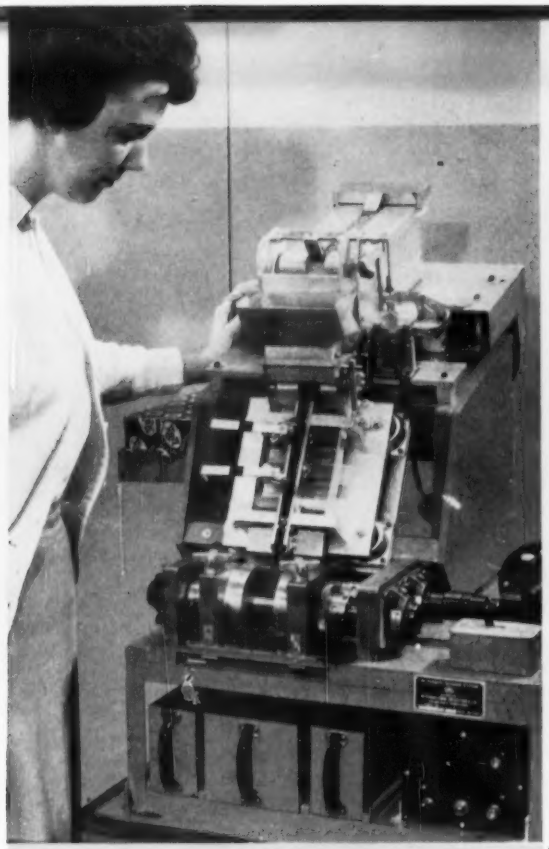
The perforator can punch holes ranging from 0.030-inch to 0.125-inch in $\frac{1}{16}$-inch XXXP paper-base phenolic with copper lamination. Punching is done at room temperature. The hole size most commonly used is 0.042-inch. Maximum excursion on a given board is 5 inches. The perforator is now being used primarily for military communication equipment production.

The template is twice the size of the finished board to give increased accuracy. Preparation of a new template requires from 2 to 8 hours, depending on its complexity, but setup time is only 10 minutes. Registration is with reference to two adjacent sides of the wiring board, pressed against pins and the side plate of the holding device.

Construction of an electronic control for the perforator, operating from a loop of standard 8-hole Flexowriter tape, is now well under way. When used in conjunction with an automatic loading device, this will make the perforator entirely automatic. Four of the holes on the tape serve for positioning control of one axis and the other four serve for the other axis. Points to be punched are located to 0.005 inch.

Template-Guided Turret Press. A new Wiedemann turret punch press designed specifically for high-speed piercing of wiring boards has an operating rate of 80 to 120 holes per minute. The operator loads a board into the holding fingers of the machine, then moves a hole locator over a color-coded template. The press trips automatically each time the locator is positively engaged in a template hole.

When all holes of one size are punched, the operator touches a foot switch to swing the next color-coded punch into position automatically, then proceeds to place the locator in each template hole of that color in turn. A



LEAD CUTTER—Boxes holding 2,500 axial-lead resistors are automatically unloaded into chute of IRC machine, for cutting leads to correct length at rate of 30,000 resistors per hour

LEAD CUTTER—Motor-driven shearing blades and ferris-wheel feed on RCA machine solve problem of cutting limp, bent leads of heavily waxed tubular paper capacitors

thermostatically controlled heating element in the table of the machine maintains the desired punching temperature in preheated laminated boards. Punching accuracy is within 0.005-inch tolerance for hole sizes ranging from the smallest lead holes up to 4½-inch openings.

Template-Guided Drill. The DuMont semiautomatic Pantodrill for small runs of wiring boards will turn out a 150-hole board in about 2 minutes, working from a phenolic template that can be prepared in about 30 minutes. Accuracy of positioning is within 0.002 inch.

With the template in position, the operator places a board up to 18 inches long over two positioning pins on the table of the machine, directly below a drill press driven by a Dumore air motor. The board table is free to move in a horizontal plane and is attached to a tracing stylus by means of a pantograph linkage. When the operator guides the stylus to a hole and pushes it down against spring loading, contact with the metal underneath completes a control circuit that serves to lock the table and initiate downward movement of the drill press. A pressure-sensitive feed controlled by compressed air automatically adjusts drilling speed to the characteristics of the material being drilled. With drilling, there is no need to preheat phenolic boards to prevent chipping and cracking.

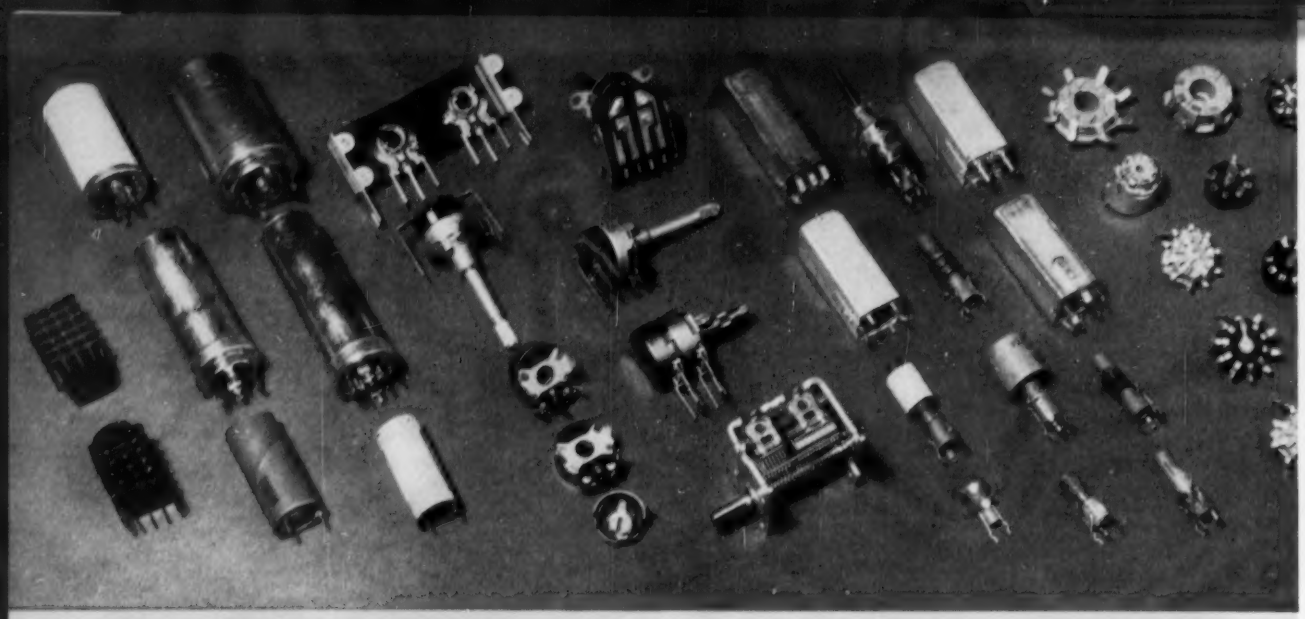
When hole locations are controlled by a template, there is no need to place holes on a predetermined grid structure, as is necessary with a programmed machine. The only tooling cost for a change in design is the template material plus 40 minutes labor for drilling the template. The two guide holes must be punched or drilled in the boards beforehand with precise positioning.

Punched-Tape Press Control. A programmed punching machine announced by RCA operates under the control of punched paper tape to perforate 0.052-inch holes at 0.10-inch grid intersections. Even though producing one hole at a time, the machine will in 45 seconds produce any desired combination of holes in any number of circuit patterns on boards up to 6×17.6 inches in size. The production rate is 60 boards per hour, including loading and unloading. Only one operator is required.

Preparation of a control tape for a new design requires approximately 4 hours. Once the control tapes are available, changeover of tapes takes only about 6 minutes.

An automatic punch press developed by GE for the Signal Corps also places holes in wiring boards under punched-tape electronic programming control. This machine has a motor-driven rotating head containing a variety of punch sizes, and a movable board-holding platform capable of positioning in two directions on a horizontal plane under action of a combination of air and hydraulic cylinders. The air cylinder is used to position the platform rapidly in approximately the correct location. A hydraulic cylinder then takes over for precise positioning to 0.001 inch.

Lead Cutters. A completely automatic lead cutter developed by IRC will cut leads of carbon resistors to desired lengths at rates up to 30,000 resistors per hour,



NEW LOOK IN COMPONENTS—Etched or plated wiring boards call for plug-in terminations, with either plug-in or snap-in mounting tabs for larger components. Sockets are designed for insertion in single large punched holes or for stand-off mounting in individual terminal holes. Biggest change in appearance occurs in potentiometers. Small axial-lead resistors, capacitors and diodes require no change, since their leads can

the operator merely loads standard packages of 2,500 resistors and removes the tote box as it becomes filled with cut components.

The carton-unloading mechanism utilizes a combination of a shaking motion and gravity to push resistors over the edge of the box each time a gate opens in response to a photoelectric feed control system. The resistors move transversely down a chute, with bodies parallel and touching. At the bottom, their leads pass between two pairs of rotating cutters that can easily be set to give any desired equal or unequal lead lengths.

Many different semiautomatic lead cutters are in use. Usually the operator loads the components one by one between teeth of a ferris wheel or sprocket chain, for transport through rotating lead cutters or motor-driven chopping blades. Magazine feed is used with chopper blades driven by a continuously cycling air cylinder in another setup, where the cut components drop directly into assembly-line tote boxes. Some setups form the leads also, for manual insertion.

Magazine Loader. The component preparation machine developed by General Mills is automatic in operation once the axial-lead units are placed in its hopper. The machine feeds them one by one into a transfer wheel where the leads are straightened and cut to length. For components which are to be mounted off the wiring board (as required for IBM's radar boards), the machine also places wrap-around sleeves on the leads. The prepared units then slide down into a waiting magazine. After each magazine is filled, the machine indexes to the next empty magazine until eight are filled.

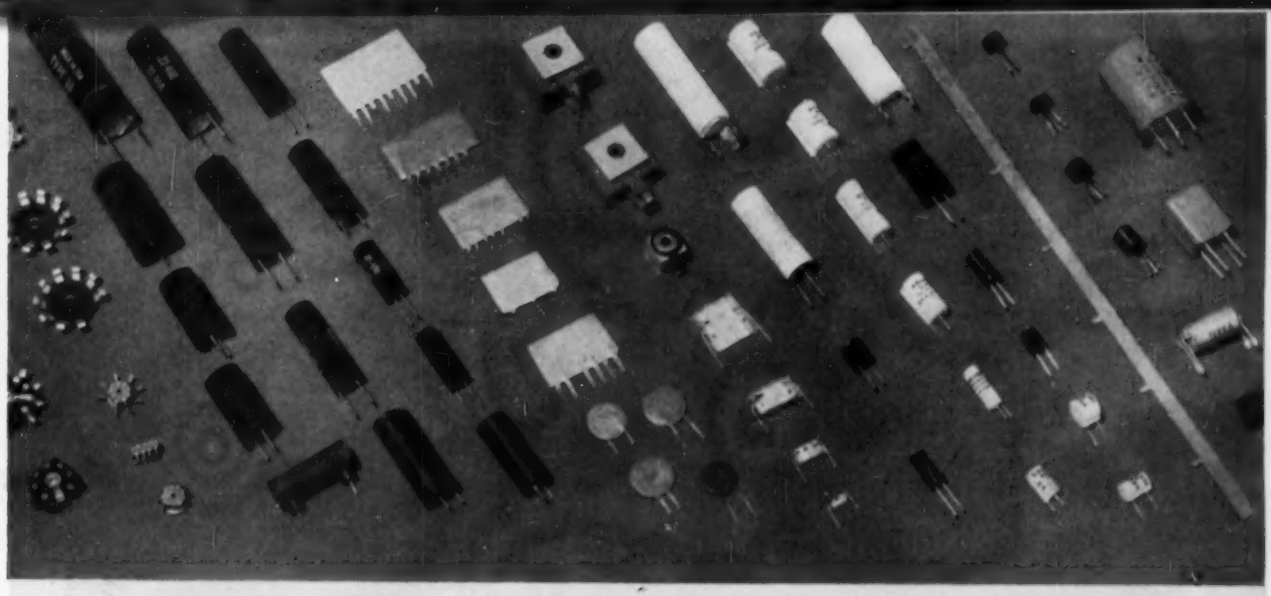
New Look in Components. Redesign of terminations for hand assembly in wiring boards is the first step by component manufacturers to meet the new demands of the electronic industry. This has largely been achieved already, as can be seen in the product lines of such representative manufacturers as Aerovox, Astron, Centralab, Chicago Condenser, Chicago Telephone, Cinema Engineering, Clarostat, Corning, Eastern Precision Resistor, Elco, Mallory, Methode, Radio Receptor, Sangamo, Sarkes Tarzian, Sprague, Stackpole, Standard Coil, Sylvania and UTC, as well as many others.

Next will come modification to meet the requirements of automatic assembly machines. In many cases the existing designs with single-ended terminations are already usable. For others, particularly sockets, electrolytics and i-f transformers, it will be necessary to add flats, tabs, slots, off-center holes or appropriate terminal positioning to permit orientation by assembly machines. Attention must also be given to the problems of belting or magazine loading. Terminals will have to be straighter and more precisely positioned. Final designs will have to be worked out by component and machinery manufacturers in cooperation with RETMA and other industry standardization committees.

Terminations for wiring boards are likewise in a state of transition at the moment. Radio and tv manufacturers use a variety of individual terminals staked into boards for interconnecting purposes, as also do many military and industrial electronic manufacturers. The latter two also use multi-terminal connectors such as are made by Amphenol, Continental Connector Corp. and Elco, which permit plug-in and removal of the entire board at will.

Several manufacturers have inserted i-f transformers automatically on an experimental basis. Development of insertion heads for these is well under way, with loading from tape-belted single-sided reels or from magazines. A 20-inch reel would hold about 400 average transformers, enough to feed a machine head for about 20 minutes.

A survey by Automatic Mfg. Corp. indicated that 17 firms were now inserting i-f transformers manually in wiring boards but will probably use machine insertion later. Three firms plan to start and continue with manual insertion, while two plan to start with machine insertion in



be cut and formed beforehand or at time of insertion. Except for greater uniformity in lead position, disk capacitors also retain their familiar look. Long metal strip is stiffener that plugs into center pins of in-line sockets to prevent large Westinghouse phenolic board from warping during dip-soldering. At right of strip (upper right corner) are pulse, audio and transistor transformers

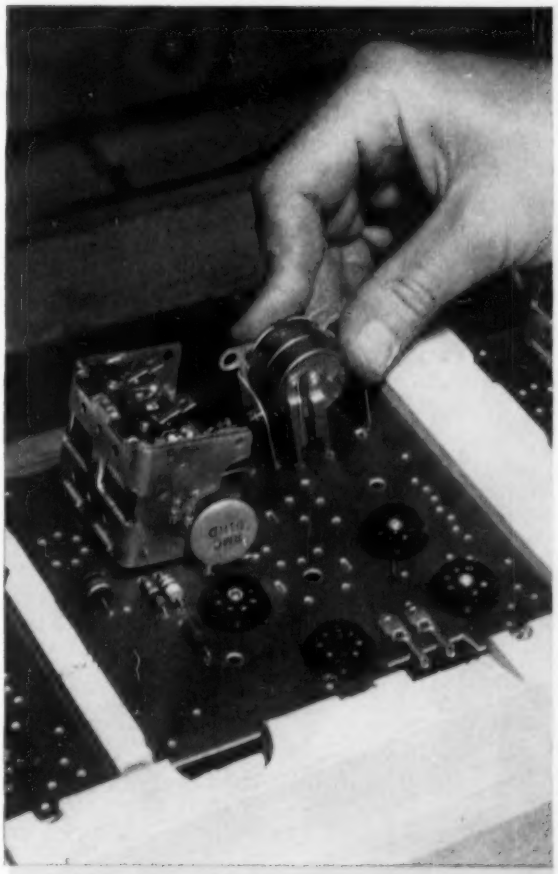
etched wiring boards for radio and television receivers.

The chief requirement for coil terminals is that they be stiff enough to stay straight during normal handling, without toe-in. Snap-in terminals are favored by some, while others are satisfied with straight terminals and snap-in mounting lugs that hold the transformer on the board until it is soldered. Still others favor long, thin terminals that can be clinched after insertion the same as with pigtail leads.

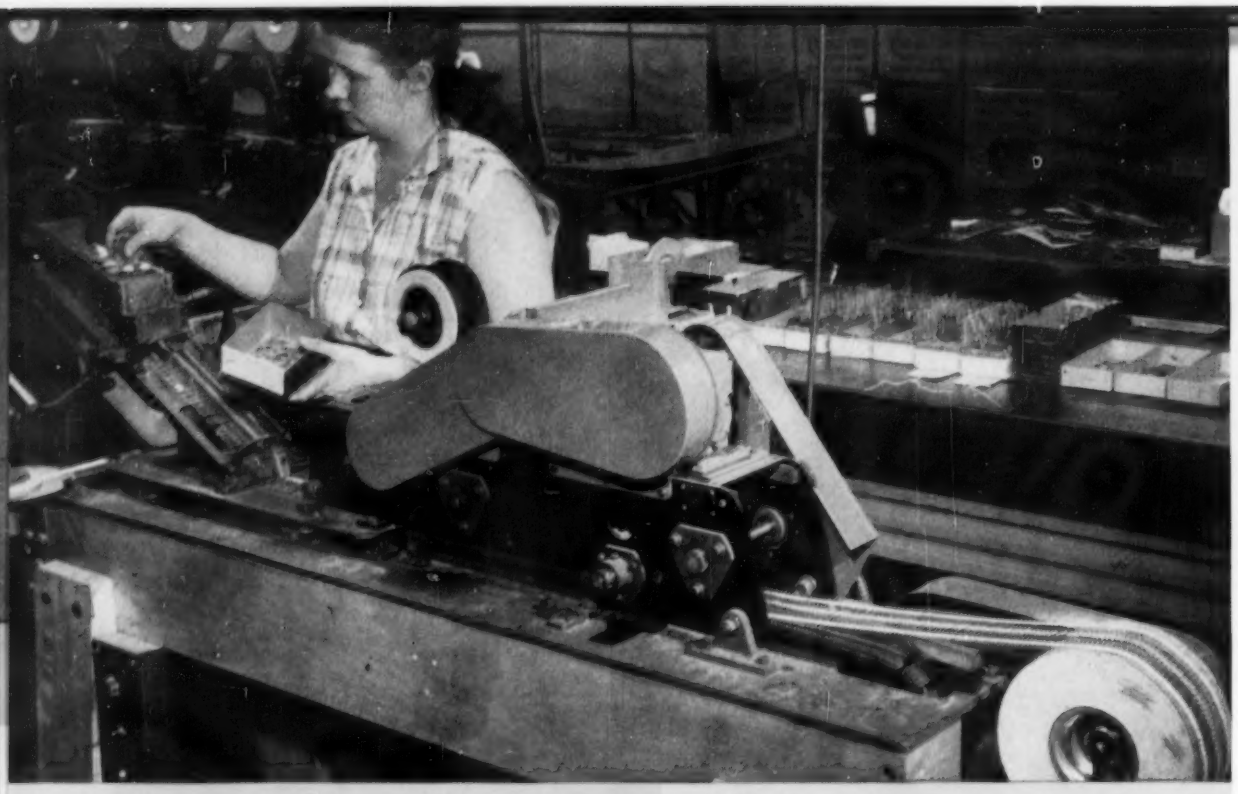
Summarizing the new look, modules have leads suitable for direct insertion in wiring boards. Can-type electrolytics change little in appearance, except that snap-in mounting lugs replace the twist-type. Controls change most in appearance; new designs display considerable ingenuity in getting terminals and control shafts out at the required directions. Even gang tuning capacitors for radios have gone plug-in, though with manual loading as yet. Transformers and coils for r-f and i-f boards look much the same. Sockets are single-hole snap-in types except for an occasional unit that stands off the board like a spider.

Paper capacitors with axial leads can be handled like resistors, but more and more plastic-housing units have plug-in leads at one end. Coupling plates and ceramic capacitors remain unchanged except for greater precision of terminal location; some have wedge-shaped flat terminals in place of wire leads. Selenium rectifiers get snap-in terminals. Wire-wound resistors are getting the same plug-in terminations as some paper capacitors. Transistor transformers, smaller than marbles, and various other types of transformers likewise are coming out with single-ended terminations.

Component-Belting Machines. When assembly machines use belt feed, the components must first be taped together for storage on reels. United Shoe's automatic belting machine for resistors uses four spools of ¼-inch pressure-sensitive tape, two on each side, to produce a lead-taped belt. When feeding from a bulk-type resistor



INSERTION—Bulky and odd-shaped components are now inserted in boards by hand as on this Westinghouse line, but automatic insertion heads will eventually do this job too



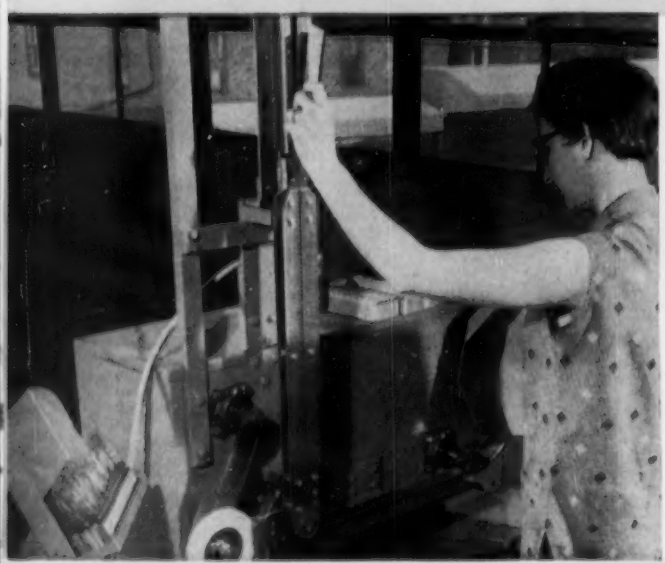
BELTING MACHINE—Resistors loaded by handfuls into hopper of United Shoe's machine in Indianapolis RCA plant are fed into chute with air assist, dropped into teeth of sprocket chain for precise spacing, rotated between metal plates to straighten leads, then run between pairs of adhesive-tape strips form desired chain-like belt that is reeled up for use on insertion head

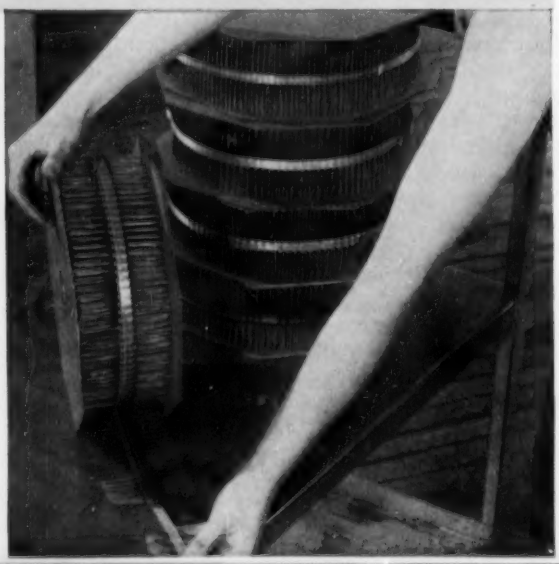
package, the operator feeds resistors into the hopper a handful at a time and aligns them roughly. Components flow from the hopper into the raceway, the motion of the resistors being assisted by an air stream and vibration.

At the bottom of the raceway the resistors drop one by one into pairs of teeth of a sprocket chain. This serves to space the resistors accurately. The chain first brings the resistor bodies under a motor-driven rubber roller. This rotates the leads between metal plates for straightening. Rubber rollers then press the tape lengths together against the leads to form the desired chain-like belt.

Allen-Bradley has a number of machines for body taping of axial-lead components. The parts drop down a slide by gravity into a sprocket-type feed wheel that gives uniform spacing. A rubber roller presses the tape firmly against the parts while they are on the feed wheel.

BELTING MACHINE—Resistors or capacitors in corrugated paper sleeves are fed into vertical feeder slide of Allen-Bradley machine for body taping on Minnesota Mining's filament tape at rate of over 20,000 units per hour (10 to 20 filled reels, depending on component size). Twelve-inch tape leaders facilitate loading and splicing on assembly machines. Reels are expendable





3. MACHINE ASSEMBLY

Some two dozen huge machines for inserting components, terminals and jumpers in wiring boards are in operation or under construction today. Hundreds of smaller machine setups are used with manual loading as an experience-getting interim step

For the high-volume requirements of radio and tv plants, computers and some military items, in-line assembly machines as developed by Admiral, General Mills and United Shoe are favored. Here the wiring board moves from one station to the next while components are inserted, just as on a manual assembly line.

Although differing in details of board transport, board position, component feed and method of inserting components, all in-line machines have essentially the same production rate of 20 to 30 boards per minute or over 10,000 boards per 8-hour day. Likewise, all stop automatically when a malfunction occurs, so that no rejects get through. A single lamp comes on at the station in trouble, to guide the operator in clearing the jam. She can then operate the head individually to insert a new component.

Admiral Machine. Admiral has six automatic assembly machines running and one more under construction, with an additional 44-station machine being built for RCA. All eight are expected to be in operation by year-end.

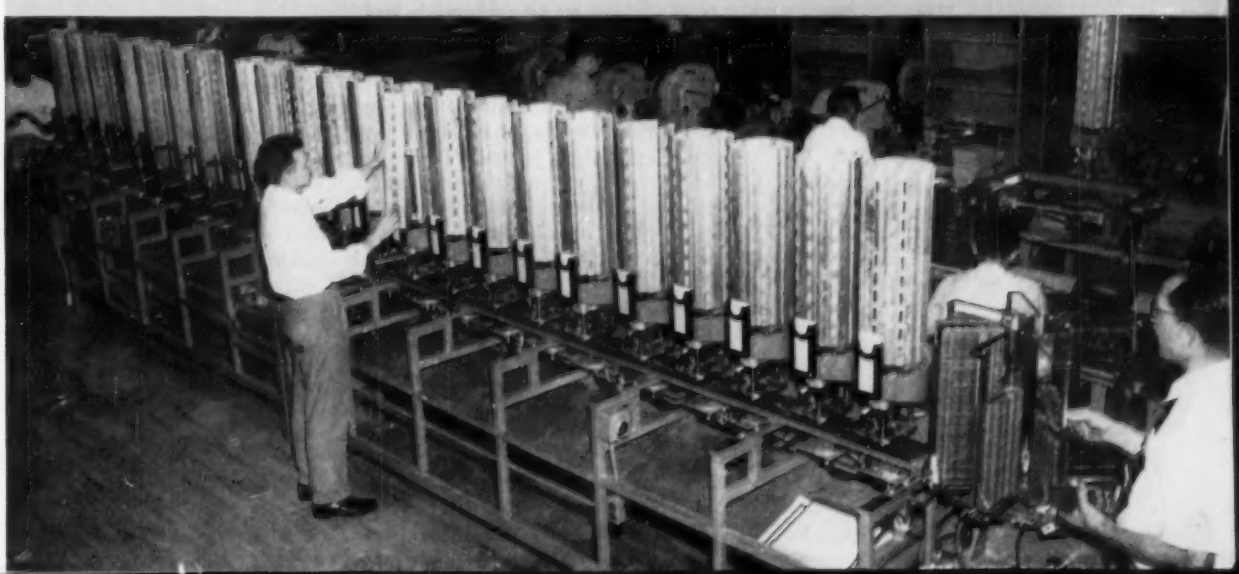
Admiral will be using one of its seven machines for a radio board, two for a tv audio board, two for a tv sync board and two for a tv i-f board. Of the 231 components on three tv boards, a total of 190 will be assembled by machine, including 13 sockets. This figure will creep up gradually as new insertion heads are developed, working toward the goal of completely automatic insertion so that finished boards can slide right into an automatic dip soldering machine.

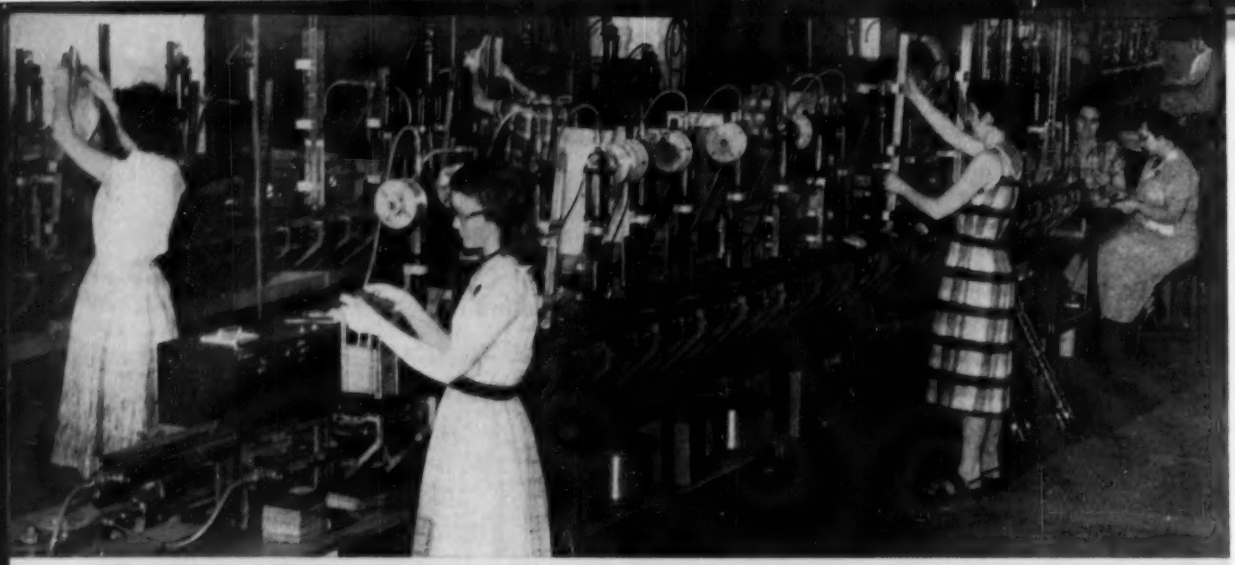
General Mills Machine. General Mills entered the electronic mechanization field with its 24-station Autofab machine built for IBM. This uses wrap-around sleeves on component leads and special forming jaws in each head to give the off-the-board mounting required by the intended application—assembly of thousands of boards in some hundred different designs for early warning radar computers to be installed at U.S. Air Force stations. The sleeves are driven into the plated-through holes in the board to give a tight mechanical connection that is later augmented by dip soldering.

The commercial version of the Autofab machine has conventional insertion heads and clinching anvils in place of the more costly sleeves for leads. The firm reports orders for three such machines.

Autofab machines use magazine loading; each head has an automatically indexing turret holding eight magazines,

IN-LINE MACHINE—General Mills Autofab as built for assembly of radar computer boards in IBM's Kingston, N. Y. plant. Eight-compartment loading turret at right takes boards with interconnecting terminals already inserted. Each head has self-indexing turret holding eight magazines. Boards are pushed along rails from station to station by two-chain conveyor





IN-LINE MACHINES—These three machines in Admiral's plant insert over 70 percent of the required components in the three boards currently used in the firm's television receiver. One air cylinder pushes boards down rails, without use of pallets, while another cylinder locks boards over conical positioning pegs at each station. Some stations have up to three heads

INSERTION HEADS—Dumping 7-pin sockets into hopper of Syntron feeder, for orienting by missing pin and loading into magazine that slips into position on Admiral's socket-inserting head. For same machine, body-taped capacitors in strips about 18 inches long are dropped into loading chute of capacitor head and tape is pulled off. Leads are cut and formed by head

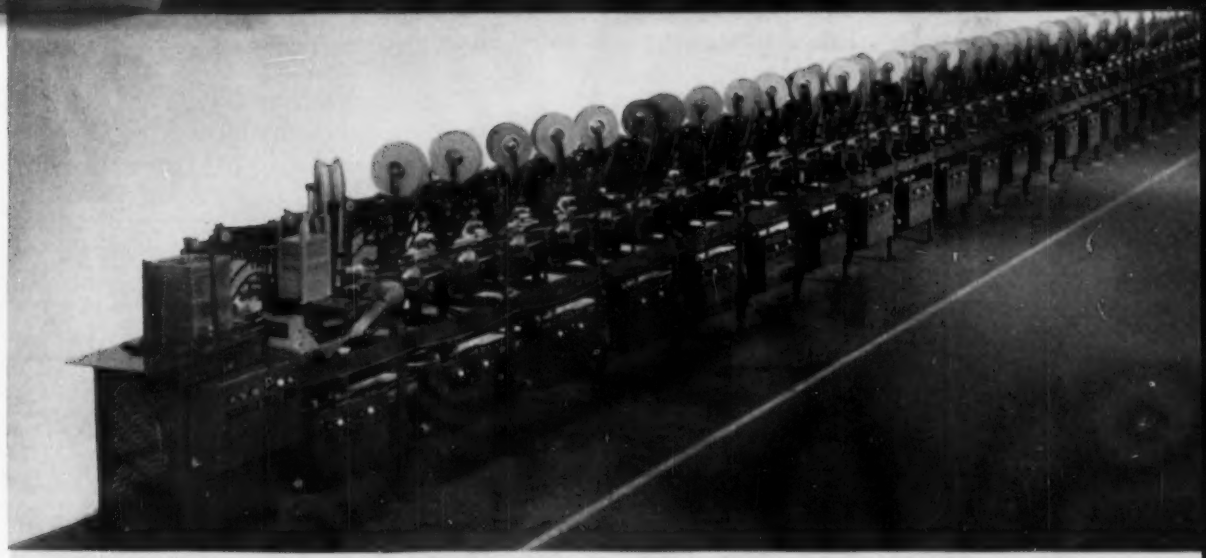
which advances one step when a magazine runs out. Power for turret rotation is obtained from a small horizontally mounted air cylinder inside the head. A somewhat similar eight-position turret feeds boards into the machine.

General Mills chose to cut leads beforehand to reduce the number of cutters and to simplify head design. The machine normally runs at 20 insertions per minute, whereas lead cutters operate at many times this rate. Omission of cutters from the insertion heads reduces the number of possible trouble points and eliminates the problem of disposing of cut ends of leads. Preliminary cutting also permits straightening of leads, with resulting further assurance of trouble-free insertion.

United Shoe Machine. United Shoe has acknowledged receipt of firm orders for at least six complete assembly systems. These systems average about 30 stations per machine.

Five machines have already been delivered. Two are in RCA's Indianapolis plant, starting as 44-station machines handling only axial-lead components; one of these will be elongated to 56 stations when new insertion heads are delivered.

At the present time, United Shoe uses double-tape belting across the ends of the leads. This requires four strips of tape, facing each other in pairs with the leads between the pairs. The tape required costs about 17¢ per thousand



IN-LINE MACHINE—Forty-station automatic assembly machine delivered by United Shoe Machinery Corp. to a leading radio-tv assembler, as set up for initial tests. Pallet return conveyor running under machine has since been added, providing completely automatic handling of pallets and replacing pallet feeder shown at left. Heads shown are belt-loaded from reels

parts, and the taping operation brings the total cost of component preparation up to about 25¢ per thousand parts. If experiments now under way are successful, tape costs will be almost halved by using adhesive on only one side of each lead and ordinary paper ribbon on the other side.

Body taping is still cheaper because only one length of tape is needed. With body tape, it is essential that the tape hold tightly during extremes of temperature and humidity and yet strip free without leaving a sticky residue or taking the paint off the component.

The chief deterrent to bulk loading of axial-lead components on individual insertion heads is the cost of the required vibratory feeder and its mounting. Another problem is that of reaching the hopper of the feeder if it is mounted in its logical position atop the insertion head. For these reasons, RCA has elected to use double-tape lead belting with its two United Shoe machines, but plans to go to less-expensive body taping just as soon as this appears feasible.

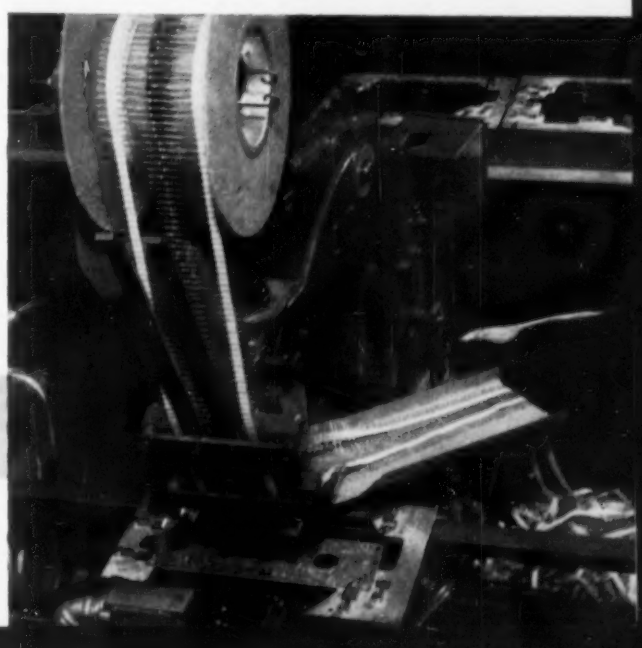
With either body or lead taping, an empty reel is easily replaced without down time, because the insertion heads have ample component storage capacity below the reels. New reels have leader strips of tape that serve for splicing.

After installing some half-a-dozen parts in over 150,000 radio wiring boards with a pilot-model United Shoe machine, Emerson has ordered a 37-head machine capable of installing practically all parts on their radio board and on one tv board. It is planned to alternate scheduling of the two boards, probably on a daily basis since changes in setup can be made before or after the regular working day. Three men can change the entire machine setup in less than an hour, allowing 4 minutes per head.

Other Assembly Machines. One set manufacturer uses several four-station machines of its own design to assemble a five-tube etched-wiring radio. Body-taped resistors and capacitors on reels are the only components inserted at present. The insertion heads cut, form, insert and clinch in much the same way as other in-line machines.

Development of a batch-loading socket-inserting head for automatic assembly machines has been announced by Elco Corp. With minor adjustments its Syntron vibratory elevator will handle and orient a number of different types of sockets. Orientation is by means of molded studs on the socket.

Market for Assembly Machines. It is estimated that 50 assembly machines having an average of 40 stations each will handle the present requirements of the electronic industry. This estimate may prove too conservative, because a recent survey by Stavid Engineering indicates that

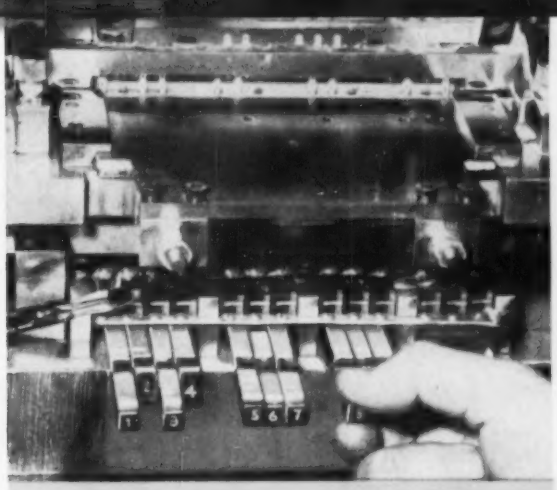


BELTING—Resistor-inserting head on RCA's United Shoe assembly machine, showing pallet for rectangular video i-f board and salvage-bin chute for taped cut-off leads

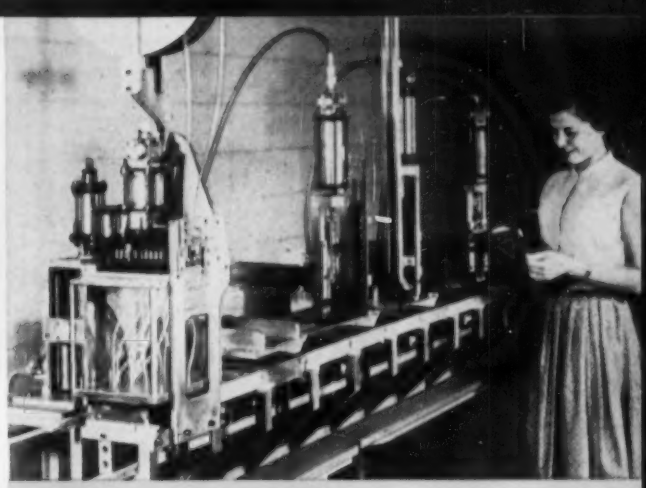
Comparison of Three In-Line Automatic Assembly Machines

	Admiral	General Mills	United Shoe
Status of production	Six machines in operation and one under construction for own plant; one 44-station machine scheduled for Oct. delivery to RCA	One machine in operation at IBM's Kingston, N. Y. plant; three more under construction to fill orders	Five machines delivered, including two to RCA and one to Emerson; additional machines under construction to fill orders, one of which goes to Stromberg-Carlson
Speed	12 boards per minute	20 to 30 boards per minute	20 to 30 boards per minute
Board feed	Automatic feed by pushing from bottom of single stack of etched boards, without pallets	Automatic feed by dropping from bottom of one of eight stacks of boards on input turret, without pallet. Boards may have terminals	Automatic feed by pushing from bottom of single stack at input of machine, for automatic loading into aluminum pallet
Board transport	Wiring board slides on rails, without pallet. Air cylinder moves rod running length of machine, having pusher bars that come up to move each board to next station, then retract and return	Board slides on rails, without pallet, and is pushed from station to station by spring-loaded fingers projecting from two-chain motor-driven conveyor having differential drive controlled by master cam	Board-carrying pallet is moved by two narrow motor-driven conveyor belts that run continuously. Closed-loop pallet return system running under machine requires only eight more pallets than stations
Board positioning	Second master air cylinder moves machine-length rod having cams that pull down side-rail segments at each station so as to bring two reference holes on each board down onto conical positioning pegs	Board-stopping dog comes up in between chains of conveyor at each station. Board is accurately positioned and clamped by spring action as conveyor stops. References for positioning are one long side and point at one end of board	Each pallet has projection on one side and two positioning pins. Diaphragm-type air cylinder moves machine-length rod that cams pallets sideways to (1) engage pallet positioning pins in V-notch and flat of side rail and (2) raise each pallet about 1/16" above belts
Timing	Electrical timer controls solenoid valves in air cylinder lines	Cams on variable-speed motor drive system control starting and stopping system control conveyor and heads	Timing adjusted by changing setting of conveyor time delay switch
Heads	Up to 3; average is 1 3/4 per station	One per station.	One per station
Cutting axial leads	Done by insertion head. Cut leads go down chutes into scrap box at rear	Leads are cut beforehand by automatic magazine loading machine	Done by insertion head. Cut leads and taping go into scrap box
Forming axial leads	Done by insertion head just before insertion	Same	Same
Loading axial-lead components	Batches of 25 or more in corrugated cardboard sleeves as packed by vendor are dropped into raceway on head. Body-belted capacitors in 20" strips are similarly dropped. May go to body-belting on reels later	Magazines are used. Each head has eight-magazine turret that indexes automatically as a magazine empties	Lead-belted reels are used, holding 2,500 ⅛-watt resistors. Belt is prepared beforehand by machine, using four strips of adhesive tape in pairs with leads between to give appearance of chain
Method of clinching	Roll-over clinch in any direction by pushing leads down into contoured anvils. End of lead bites into wiring	Angled or complete roll-over clinch in any direction by pushing leads down into anvil, or wiping clinch by moving fingers under board. Conical wrap-around sleeves on leads eliminate need for clinch on IBM machine	Angled or complete roll-over clinch in any direction by pushing leads down into anvil. Plan to use wiping anvils on disk capacitors and on large components having long leads that might buckle if pushed down
Loading disk capacitors	Plan to use expendable or reusable tubular magazines, with leads projecting through longitudinal slots, loaded by vendor	Plan to use magazines and grip short leads to insert or, when permissible, spread out long leads for handling like axial-lead components	Plan to use bulk feed from hopper on head, with 7/32" leads spaced 0.250" or 0.375", oriented in head
Loading tube sockets	Magazine feed now. Separate Syntron setup orients 7-pin sockets by missing pin and loads magazines	Magazine feed. Sockets are oriented beforehand by automatic magazine-loading machine	Plan to use Syntron feed from hopper to head, with orientation in head by missing pin
Loading i-f transformers	Plan to use body taping on reels. Unshielded units will have cardboard sleeves to permit taping	Plan to use magazine feed	Plan to use expendable paper magazines, with units oriented by vendor or oriented on head
Changing board width	Side rails easily adjusted from 2½" to 6". New single-rail machine removes width limitations	Shift front rail and front conveyor chain to take boards from 2" to 10" wide	Pallets take several sizes of boards. Standard pallet takes boards up to 5¼" wide and 10" long; [illegible]
Changing board length	No change needed up to length limit of 10"	No change needed up to length limit of 10"	Pallets are designed to take several lengths of boards
Adding stations	Added in five-station sections having their own extension rods for board transport and positioning. First section has drive mechanism	Added in five-station sections. First section has drive mechanism providing power and control for up to 50 stations	Added in two-station sections. Extra lengths of belt are spliced in with ordinary belt clips. One machine will have 56 stations

RESISTOR AND



TERMINAL INSERTER—Pushbuttons change pattern by which up to 41 interconnecting terminals are inserted simultaneously in wiring board by Berg machine shown on front cover



TERMINAL INSERTER—Malco unit for Admiral assembly machines chops required number of terminals from sprocket-hole strips and lets them slide down flexible plastic tubes into holes in board

the break-even point for in-line assembly machines can be as low as 50 boards. This surprisingly low figure is arrived at by balancing the cost of changing a machine setup against the cost of training workers for hand assembly and inspection of a new board design.

External Connections for Wiring Boards. Almost every etched wiring board requires external connections that cannot be made by dip-soldering. This is sometimes solved by means of special plug-in connectors, but more often the connections are made conventionally by soldering to terminals inserted in the board before assembly of parts.

The commonest procedure uses a press that automatically feeds and inserts one terminal at a time, with manual positioning of the wiring board. Some firms speed up the operation by setting the board into a metal template having appropriately located grooves and holes underneath for fitting over a positioning pin on the anvil of the press. Admiral used this technique while awaiting delivery of its fully automatic terminal inserter.

Semi-Automatic Terminal Inserters. A manually loaded machine serves for inserting terminals for Keller wire-wrapping tools in etched wiring boards at RCA's Indianapolis plant. A horizontal endless-chain conveyor operated by a foot-controlled air cylinder carries metal holding fixtures in which the operators insert the terminals. When a fixture is loaded, a board is placed over the terminals. At the next station an air-operated press stakes all terminals simultaneously.

Eyelet Inserter. With minor modifications, standard wire-terminal or lug-terminal eyelet machines can be placed on United Shoe heads. One eyeletting machine is needed for each eyelet on a board.

Malco Terminal Machine. To further mechanize the assembly of etched wiring boards for radio and tv sets, Admiral recently installed an automatic terminal-inserting machine made by Malco Tool and Mfg. Co. This machine will insert up to 40 self-retaining terminals. The complete time cycle of operation is 3 seconds, so that an operator can turn out up to 20 boards per minute. Five more of the machines will be added shortly.

Terminals in strip form are fed from two large reels supported above the machine. For each cycle, a preset number of terminals is advanced across the anvils of cut-off dies.

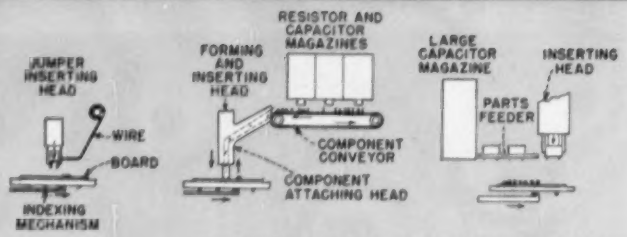
Descent of the die under air cylinder action severs the terminals from the strip, allowing each terminal to drop into its own length of flexible plastic tubing. The lower ends of these lengths of tubing are set into holes drilled in a template directly over the desired terminal positions. When a board is positioned accurately under this metal template by the feed mechanism, the terminals drop into the correct holes in the board. The board transport mechanism then advances the board to the next position on the line, where a metal platen is brought down by an air cylinder to press the terminals into the board. The design of the pin terminals is such that they are self-retaining once they snap in. The machine can be built into an automatic assembly line, where it occupies the space of two ordinary insertion heads.

Berg Terminal Machine. The Autolug machine built for IBM by Berg Mfg. and Eng. Co. gives practically instant pushbutton change of setup in inserting from 1 to 41 lugs in etched wiring boards. The operating rate is 1,380 boards per hour.

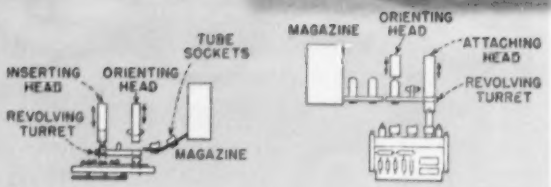
The machine uses one reel of lug strips for each of the 41 possible positions in which a lug may be needed. Each operation of the machine advances the desired strips the length of one lug, pushes the wiring board down over the lugs, shears the lugs from their strips and crimps them. Pushbuttons arranged around the machine act on plungers that stop the feed of lugs at an undesired position by disengaging the feed pivot on that particular lug strip.

Empty wiring boards are stacked in a tray at the left side of the machine, for automatic plunger feed from the bottom of the stack to the press position, thereby pushing finished boards out and down a chute.

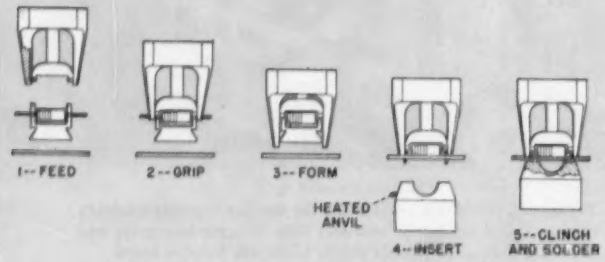
Single-Station Machines. Inherent flexibility is the prime requirement for efficient automatic assembly of extremely



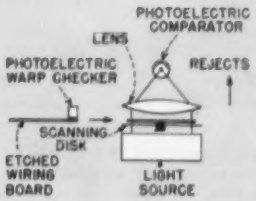
INDEXING FOR SINGLE-STATION MACHINE



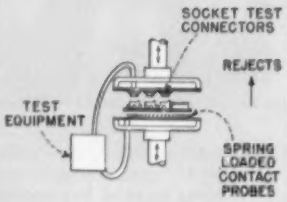
TUBE INSERTER



COMBINING SOLDERING WITH INSERTION



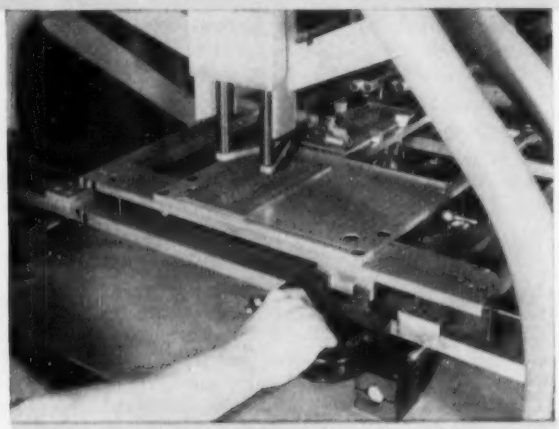
HOLE INSPECTION



TEST STATION

IDEAS FOR MECHANIZATION—A look into the future, as sketched by engineers of Stanford Research Institute and Melpar. Retractable steel pegs that come up in sequence to serve as stops for wiring board are one solution for single-station positioning. Hot-iron soldering of heavily tinned leads at insertion time is technique now being tried as alternative to dip soldering

TERMINAL INSERTER—Air cylinder presses terminals into board after they have been manually loaded into steel fixtures riding on oval stop-and-go conveyor in RCA television plant



SINGLE-STATION MACHINE—Stylus-on-template component inserter at GE's Utica plant. Each time stylus is lowered into new hole, new magazine indexes into position and feeds

short runs of wiring boards. The ultimate in flexibility is achieved when only the input materials and a memory device need be changed to produce a new design. The memory can be in the form of a template for semiautomatic operation or a punched tape, punched card or magnetic tape for completely automatic assembly at a single station. The memory device brings the components to the station in correct sequence and moves the wiring board to the correct position for each.

Ferris-Wheel Machine. One example of a template-memory machine is that used by GE's Light Military Electronic Equipment Department in its Utica, N. Y. plant to fill small-volume military electronic orders. Axial-lead components are cut, formed and loaded into formed steel magazines beforehand by a preparation machine that takes up to 25 components at a time. The magazines are then loaded onto a huge drum resembling a ferris wheel, a template is placed in position and a wiring board is loaded onto the table. As the operator guides the stylus into each hole in turn of the groove in the template, the wiring board shifts correspondingly, the wheel indexes to a new magazine and a component is fed to the head for insertion and clinching.

Melpar Machine. Another example of a single-station machine for short production runs is that being constructed by Melpar under a Bureau of Ships contract. The present model inserts six axial-lead components in an etched wiring wafer and solders the joints. Under punched-card programming, the machine will select the required component from one of six storage hoppers, transport it to the insertion station, bend the leads, insert the leads in the wafer holes, then clinch the leads with a heated anvil that also solders

them to the etched wiring on the bottom of the wafer. On each succeeding cycle another component is selected from the same or a different hopper and similarly inserted and soldered after appropriate repositioning of the wafer by an air-actuated servo system.

The operating rate of the machine is 2 seconds per insertion or about 12 seconds per wafer. Changeover for a new design, involving changing all component parts, all wafers and the punched card memory, takes about 5 minutes.

The required amount of solder for achieving a good joint is provided by electroplating an 8-mil layer of solder over the copper foil in the pattern of the desired wiring. This solder then serves as the resist for etching out the unwanted copper.

As presently conceived, the Melpar machine requires that tinned eyelets be used in all holes

Other machines are planned for combining the wafers into subassemblies and testing them, to complete the programmed assembly system.

GE-Signal Corps Machine. Working under Signal Corps contract as a logical continuation of this agency's Auto-Sembly system, GE now has in operation practically all of the individual machines that make up an automatic component assembly system. This single-station system uses punched card programming, and will be completely automatic through dip soldering and test when fed with the required components and etched wiring boards.

The system is unique in its use of individual carriers for the components, with the carriers in turn going into magazines.

The wiring boards travel through the machines on special metal pallets designed to take boards ranging from one inch square up to 8×12 inches.

The component preparation machine, a part of the system, serves to load the carriers. For axial-lead components this involves cutting and forming also.

Each magazine holds 20 carriers, and boards are put through in batches of 20. As the board feed system brings each pallet in turn up to the insertion head, the pallet and head are servoed to the proper position for receiving the component from its carrier. When all twenty carriers are empty, the punched card memory takes over to remove the empty magazine, bring in the next full magazine, servo the head and the pallet guide system to the correct positions for that component, then repeat the recycling of the 20 boards.

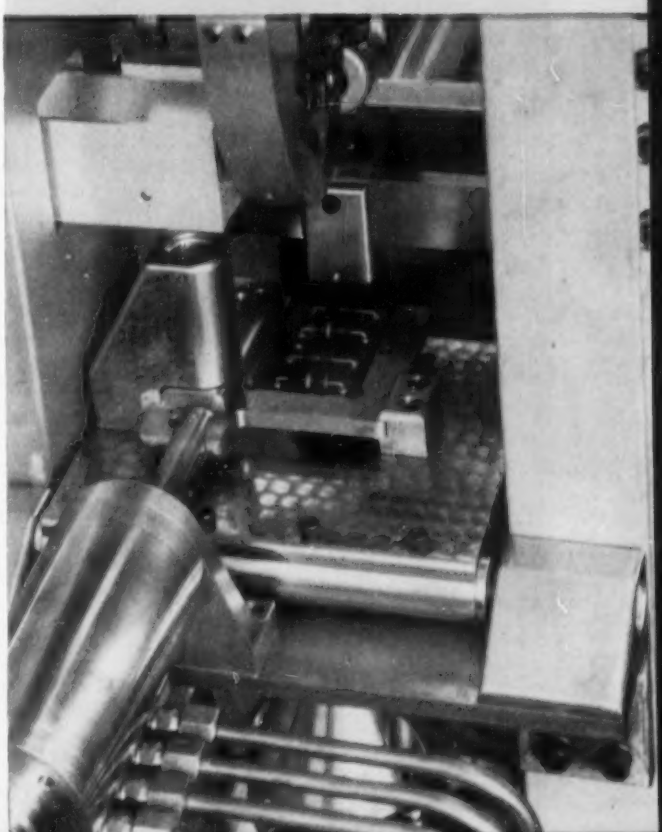
When the last component has been placed on a board, its pallet is routed to the automatic dip-soldering station. Here the board is sprayed with flux, dipped in solder, cooled, then passed on to the automatic test station. Tested boards are automatically accepted or rejected, then discharged from the system.

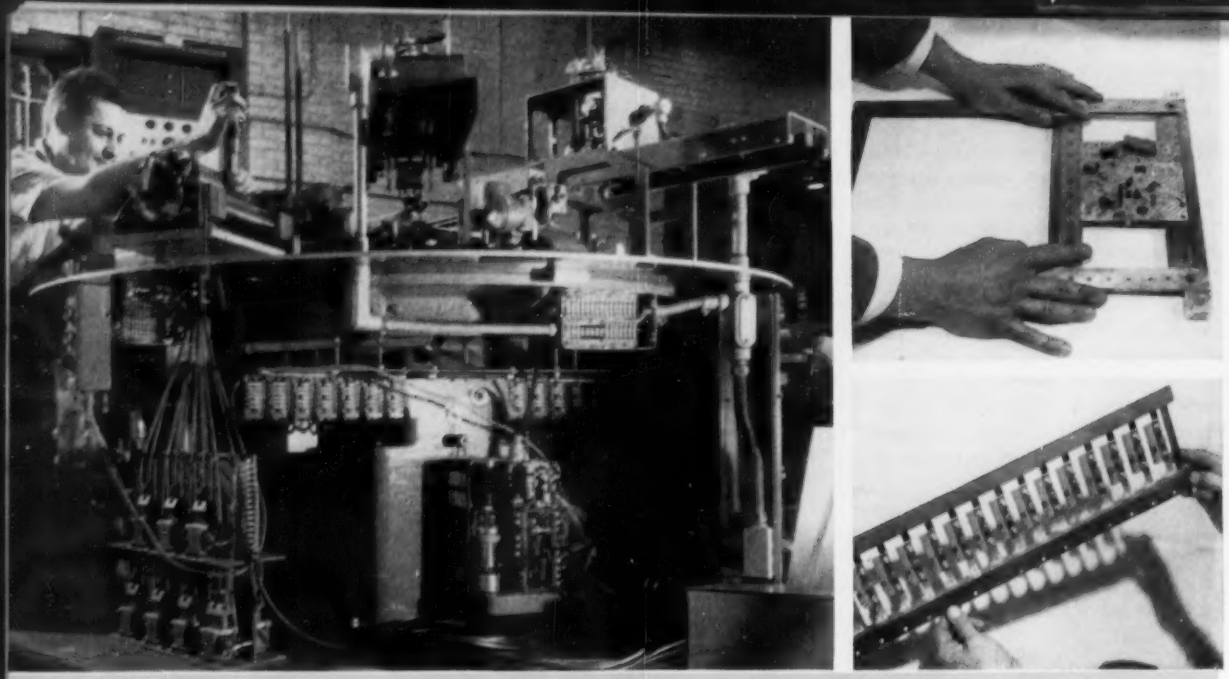
While in the solder bath, the board is vibrated to bring the solder into more intimate contact with the joints. Vibration is continued while the board is tilted up from the solder bath, to remove excess solder while still molten

Module Machines. Project Tinkertoy has gone three ways. Basic research continues at the National Bureau of Standards, with tape capacitors and printed resistors receiving particular attention.

At ACF Electronics in Alexandria, Va., a plant has been

SINGLE-STATION MACHINE—Programmed system, under construction for Bureau of Ships by Melpar, will have punched-card control of magazines and air-servo positioner. Present model feeds board automatically and inserts choice of six different components at six positions on board in sequence. Clinching anvil is heated for self-soldering. Pushbuttons permit manual operation





SINGLE-STATION MACHINE—Component preparation and test turret of programmed assembly system now being constructed for Signal Corps by GE. Wiring-board pallet and component carriers in magazine are shown alongside. Punched cards control automatic loading of specified components into carriers and cycle boards through insertion station until each magazine in turn is emptied

set up for producing modules commercially under the tradename Compac. Machinery here is of new design, streamlined for economical commercial production with a reported production capacity of 500,000 modules per month. Both Emerson and DuMont have announced plans for use of the modules in forthcoming tv sets.

The ACF modules retain the original ceramic wafer stack but now mount in a single square hole in an etched wiring board. The 12 riser wires, surrounding a square socket on the top plate, are pushed up into the square hole from below, and a four-blade tool is used to bend the riser wires down onto the corresponding etched wiring on the top of the board. After masking the socket holes, the board can then be dip-soldered conventionally.

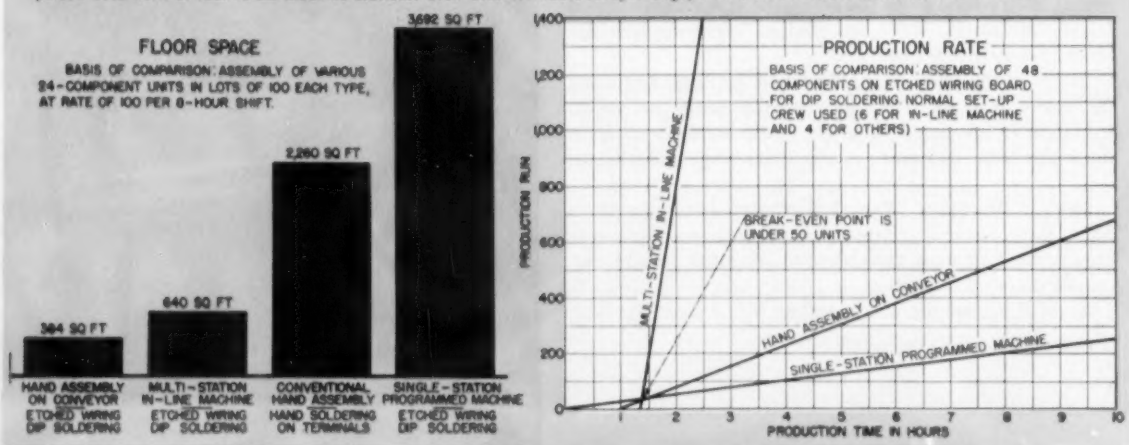
Aerovox has leased the original Arlington, Va. module-building plant from NBS. It plans to conduct a research program aimed at evaluating both the commercial and military market for modules serving as single stages.

As reasons for going into modules, Aerovox cites the reliability record of equipment already in use embodying modular construction. Along with ACF, the firm believes it is possible to produce a module that will sell for approximately the same price as equivalent components purchased individually.

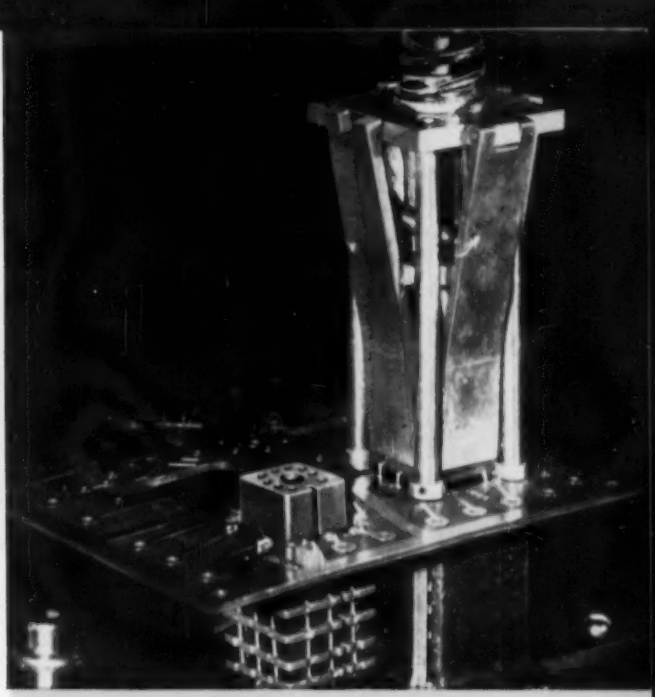
Single Insertion Heads. Single heads mounted for bench use in conjunction with manual positioning of etched wiring boards are being made available by General Mills and United Shoe. These can be operated by foot power, by an electric solenoid or by the same air cylinders as are used on the in-line assembly machines.

With the head appropriately loaded, the operator places one board after another on the machine for insertion of a component, until the entire batch has been run through.

COMPARISON CHARTS—Statistics compiled by Stavid Engineering for Navy's Bureau of Ordnance compare floor space requirements and output rates for various production methods. Hand assembly of etched wiring boards on conveyor takes least floor space because one person does work of four to six machine stations. Even with 1.4 hours setup change, in-line machines are faster for runs over 50



MODULES—Now under Aerovox management is this Arlington, Va. module-making plant originally built by NBS for Project Tinkertoy. Commercial market for modules will be explored



MODULES—Insertion head for installing modules on etched wiring boards, developed at ACF in Alexandria, Va. plant as part of program to make product economically attractive

She then reloads with the next component and runs the boards through again, repeating this process as often as necessary. Various fixtures can be used to aid in precise positioning of the boards.

SRI Insertion Head. A basic insertion head developed by Stanford Research Institute will give up to 36 component insertions per minute, with automatic indexing of the board along one axis for up to ten positions. Leads must be cut to length beforehand. The pilot model of the head requires manual loading, but magazine loading can be readily added.

Minn-A-Matic Insertion Head. A single-head insertion machine for body-taped axial-lead components, ready for delivery early this fall by Minnesota Engineering Co., combines drilling with inserting and clinching. Boards are run through vertically by hand for low-volume batch production.

Boards are inserted to an adjustable stop and the machine is actuated by a foot pedal. The machine then clamps the board, runs two drills through it from the left while the leads of a component are cut and formed at the right, retracts the drills, then inserts the leads into the freshly drilled holes and clinches them flat against the wiring pattern with wiping arms. Correct hole alignment with the leads is thus assured. Angle of clinch, length of clinched tab and length of leads are all adjustable for flexibility.

Cut-and-Clinch Machines. Manual insertion is combined with automatic cutting and clinching on air-actuated machines used in large numbers as an interim to full mechanization in RCA's Bloomington, Ind. plant. Each operator inserts from five to seven components on the board manually after bending the uncut leads. These leads go

SINGLE HEAD—New General Mills unit designed for bench use, with wiring boards being fed in and positioned manually. Leads are clinched automatically after insertion

SINGLE HEAD—New General Mills unit designed for bench use, with wiring boards being fed in and positioned manually. Magazine or belt feed can replace present manual loading

SINGLE HEAD—Basic heads from United Shoe's automatic assembly machine can be used as bench machines by adding a foot-treadle switch to actuate solenoid-operated control valve

through the board and through mating holes in a large metal plate underneath that serves as the cutting and clinching die.

When her quota of parts has been loaded, the operator presses a foot valve. This operates a vertically mounted air cylinder which lowers a contoured rubber pad to push the newly inserted components firmly down on the board. An interlocking horizontal air cylinder then moves the shearing blade across from right to left under the board, to cut and clinch all the leads simultaneously. The operator then passes the board on to the next machine in the line for insertion of another group of parts.

Components are inserted in groups to give the advantages of a short time cycle and simplify the design of the clinching die. This die bends all leads in the same direction at any given position. By using a number of machines, each with its board-holding fixture oriented differently, and choosing components appropriately for each machine, leads can be clinched in the variety of directions required by the etched wiring.

CUT-AND-CLINCH MACHINES—After components are bent and inserted manually, air cylinders on these RCA machine setups push them down and then cut and clinch all leads in one operation. Each operator loads about half a dozen parts, then passes board on to nex station. At right, board is being loaded over cut-clinch blade. Foot-operated valve initiates air cylinder sequence

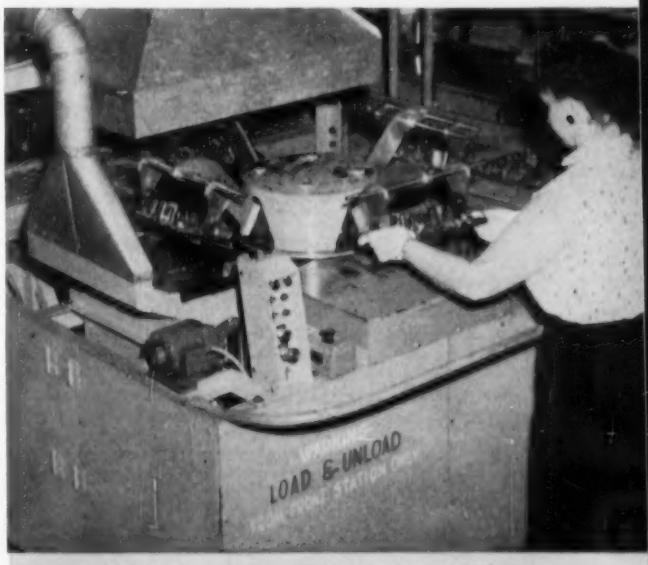
4. DIP SOLDERING

Two complex machines now under construction will hook up directly to assembly machines for completely automatic fluxing and soldering. Simpler machines, already in use in many plants as another interim step to mechanization, do the same job when loaded manually

Dip soldering is in itself mechanization even though done by hand, because dozens or even hundreds of joints are soldered simultaneously. For successful dip-soldering, four interlocking factors must be compatible—flux, solder content, temperature and time cycle. To find a compatible combination these should be varied one at a time while carefully observing results.

The solder is invariably 60/40, which is near enough to the eutectic point to permit lowest soldering temperatures. The exact temperature is not critical in itself, but should be held constant by thermostatic control. Temperatures currently in use range from about 440 F to about 510 F, and immersion times range from 2 to 10 seconds.

Several plants use timers started by a foot switch at the instant of immersion, to sound an alarm at the end of the selected interval. Consistently uniform time and temperature contribute to good dip-soldered joints.



DIP SOLDERING—Four-station automatic machine in Westinghouse plant has individually pivoted carrier arms that first lower board over spray-fluxing station, then float it on surface of solder

Dip Soldering Machines. Westinghouse has seven automatic dip soldering machines in its Metuchen, N. J. plant. These employ four distinctly different designs, all requiring manual loading and unloading at the present time. All handle unclinched components that are currently inserted manually on moving conveyor lines. The machines will be described in reverse chronological order, starting with the newest design.

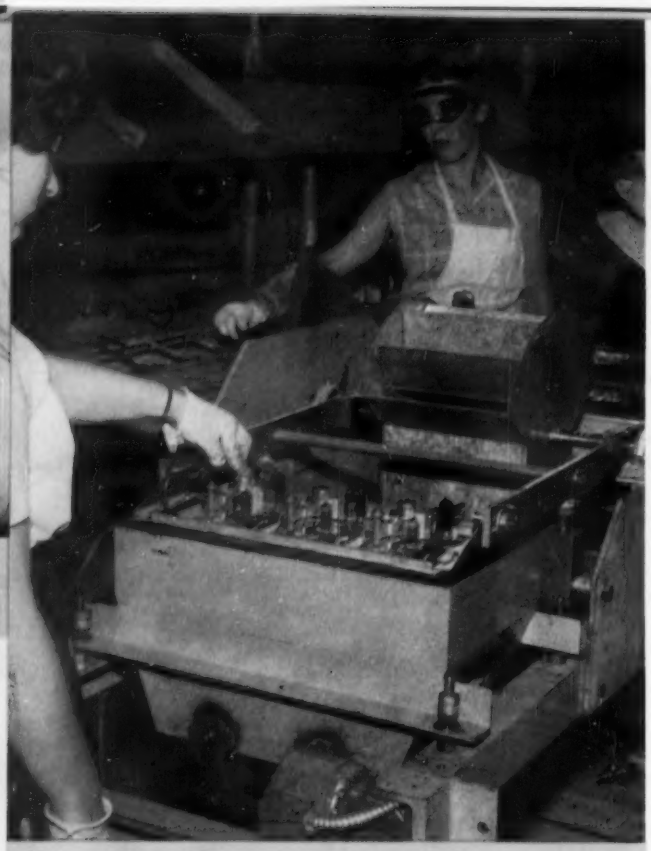
Floating-Board Soldering Machine. One Westinghouse machine has four stations 90 degrees apart around the central indexing head. This machine takes a large tv wiring board supported in a metal pallet. After being loaded at the first station, a carrier arm comes up, swings 90 degrees and drops the board down over the spray-fluxing station. Next, the board is lowered into the solder pot, where it floats on the surface of the solder. Cam-like hooks on the carrier make the board enter and leave the solder at different angles so that all joints get equal immersion.

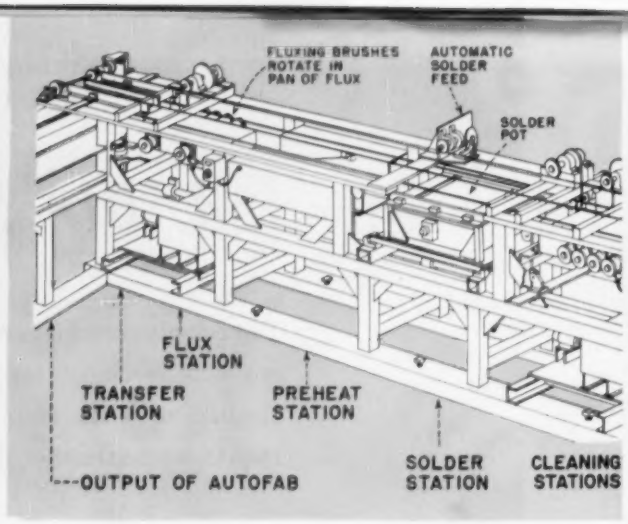
An air cylinder under timer control moves a Teflon wiper blade across the surface of the solder to push the dross over the edge of the pot. The blade then raises to clear the solder on its return stroke.

Up-and-Down Soldering Machine. A machine used on an earlier conventionally-wired Westinghouse tv chassis likewise has a four-station cycle, but the chassis is held flat at all times in a holder on a rigid arm of the machine. The entire center of the machine, with its four projecting arms, is moved up and down by one air cylinder and rotated by another cylinder. Fluxing is achieved by immersion in a pool of liquid flux. The chassis is dropped straight into the solder pot and similarly lifted straight out.

Flip-Flop Soldering Machine. For radio boards, Westinghouse uses a two-position machine in which a single carrier flips back and forth through the air between the fluxing and soldering stations. At the end of the soldering cycle, the arm rises out of the solder slowly enough for manual unloading. As in all other Westinghouse operations, the parts are inserted without clinching the leads underneath. For the greater part of its travel through the air a newly fluxed chassis passes through a blast of hot air to drive air bubbles out of the flux.

Sector-Scan Soldering Machine. The fourth type of Westinghouse machine, also used on radio sets, has a single carrier arm that swings 90 degrees back and forth horizon-





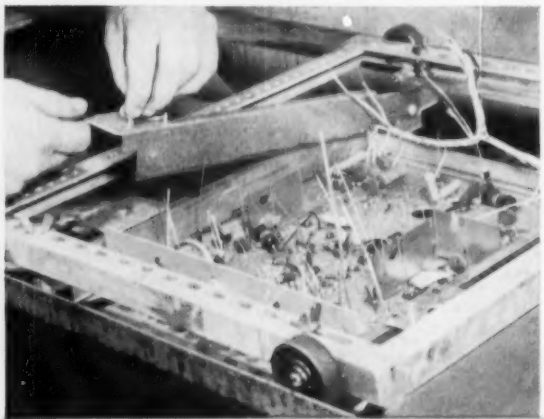
DIP SOLDERING—Machine soldering can be done in many different ways, as illustrated by these two Westinghouse designs. Flip-flop version above handles three radio boards at a time, for spray-fluxing at one end and soldering at other end after 180-degree upward swing through hot air blast. In up-and-down version below, entire central head moves up or down and rotates

tally between the soldering and fluxing station. In this early design, only the soldering operation is automatic, even though the carrier swings over the fluxing position. The operator places the pallet-load of boards over the fluxing station directly, not on the carrier, for spray fluxing. The boards are then set over a hot-air drum alongside the machine to dry the flux, before being loaded on the carrier for transport to the soldering station.

Conveyorized Soldering Machine. A dip soldering machine called the Autosol, designed by Tag Design for IBM to use with its Autofab assembly machine, is now under construction by General Mills. This will mount at right angles to the output end of the Autofab and will be driven by it through a coupling shaft running the entire length of the soldering machine. Two stainless steel conveyor chains running across the top of the machine will carry the pickup fingers for the wiring boards.

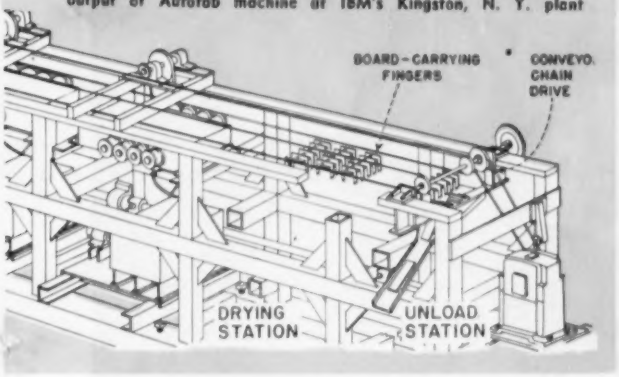
Every three seconds a set of fingers takes a finished board from the assembly machine. At the flux station, brushes rotating in a pan of liquid flux apply flux to the wiring boards.

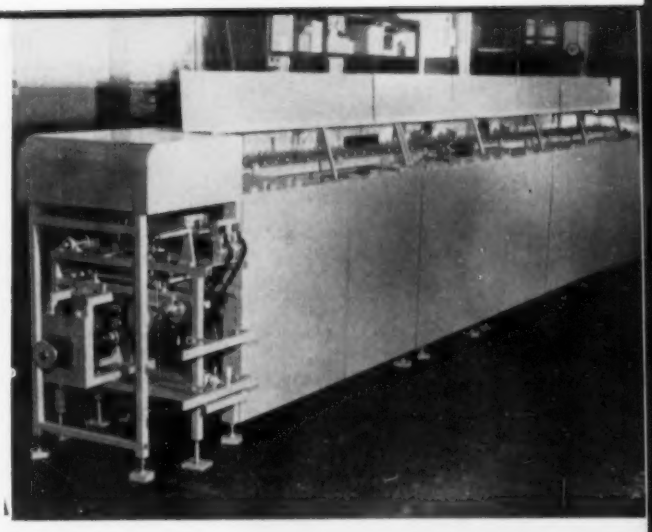
The boards next pass through a pre-heat station that



DIP SOLDERING—Locking oscillograph wiring board in carrier of trolley-car machine used by DuMont. When car is pushed to soldering position, hydraulic lift brings pot up to board

DIP SOLDERING—Comparison of design sketch with final appearance of completely automatic Autosol machine designed by Tag and constructed by General Mills for direct coupling to output of Autofab machine at IBM's Kingston, N. Y. plant





dries the flux to a tacky state, then dip down again into the solder pot. The solder level in the pot is appreciably higher than the edges of the pot. Utilization of this meniscus phenomenon permits wiping the dross right over the edge of the pot with a Teflon wiper blade mounted on the conveyor ahead of each finger assembly.

After soldering, the board moves over 120 nylon brushes rotating in a pan of flux solvent for cleaning, then through a hot-air drying chamber. At the end of the machine the fingers are opened by cams to release the board into the output chute.

Trolley-Car Soldering Machine. In DuMont's version of a soldering machine, a wheeled pallet rolling on rails moves the assembled cathode-ray oscillograph wiring board into position over the solder pot. The pot is then brought up to the board hydraulically. The height of the solder pot is precisely controlled so the terminals are in the solder but there is an air space between the solder and the wiring board.

Selective Dip Soldering. Application of solder only to joints minimizes chances of shorts between etched wires and cuts solder costs. One firm achieves such selective soldering by placing a pre-punched sheet of adhesive masking paper over the entire etched wiring pattern after assembly, so that only the joints requiring solder are exposed. The mask is stripped off and discarded after the soldering operation.

Another technique involves placing at the surface of the solder a metal plate having drilled holes for each joint. The plate prevents solder from reaching the etched wiring away from the joints. A variation of this method uses vertically-moving pipes in the solder pot to bring solder up to the joints.

Double-Dip Soldering. RCA consistently uses two solder pots. The first immersion is done rather quickly, and serves to make perhaps three-fourths of the joints satisfactorily. Just before transferring the wiring board, the operator wipes a large cake of beeswax over the surface of the second pot a few times. Somewhat longer immersion is used in the second pot, which is held about 10 F lower in temperature, to complete the remainder of the joints and give good buildup and filleting of the solder at the joints.

5. AUTOMATIC TESTING

Ingenious machine setups today measure and record electrical characteristics of dip-soldered printed boards and finished equipment automatically. The operator merely connects and disconnects the equipment, then tears off paper-tape results of the automatic tests.

Etched wiring boards are particularly adaptable for semi-automatic test setups. The boards are set into fixtures for precise positioning over spring-loaded contacts that apply correct operating voltages and take off appropriate output voltages for a performance test.

As an example, in one Westinghouse setup the dip-soldered i-f board is slid vertically into the test fixture and eight horizontally mounted captive screwdrivers are run in two at a time for the i-f alignment.

Dip-soldered tv boards are tested in semi-automatic set-

AUTOMATIC TESTING—Setup used by GE at Utica. After operator clamps board into fixture at right, CTI machine runs off electrical tests and prints results on paper tape at left

AUTOMATIC TESTING—Completely automatic GE test machine for finished military electronic equipment is programmed by punched tape. Result is recorded on tape by Clary printer

ups at RCA's Indianapolis and Bloomington plants. Three positions are usually provided, to give the required preheating before test and alignment. A board is placed over spring-loaded contacts positioned to meet with the desired points in the etched wiring. A lever is then moved to actuate spring-steel fingers that press the board down.

Automatic Circuit Testers. A single automatic electrical test machine in GE's Utica, N. Y. plant is currently handling 107 different types of etched wiring board assemblies at the rate of about 3,000 assemblies per week, with one nontechnical operator. This CTI Supertester is a sequentially programmed unit performing up to 400 separate tests on a wiring board assembly. These tests include continuity, leakage resistances, resistances, impedances and static voltages.

Each type of assembly requires an interconnecting harness and an adapter box containing standard comparison units. When a test falls outside of the tolerance range, an alarm sounds and an associated device prints on paper tape the number of the test that failed. Average processing time per assembly is 3 minutes, as compared to 45 minutes for the former manual test line using 14 Foster analyzers.

Before using the automatic tester, about one board in 100 was found to have a defect that got past the 14 check and repair operators. With the machine, only four boards failed in the final unit installation, and these were found to contain components that were broken after test.

An automatic testing machine for checking electrical connections and circuit resistances has been developed by IBM at Endicott, N. Y. Punched-card programming controls the sequence of operations and the resistance limits for each test. Card feed rate is 50 pairs of cards per minute, giving 50 tests per minute on an etched wiring assembly.

Automatic Performance Tester. Final performance testing of complete equipment has also been mechanized in GE's Utica plant. The machine used for this purpose is programmed by an endless loop of Flexowriter punched tape, so arranged that as many as four different electronic units can be tested at random on the one setup. The machine will scan the tape until it comes to the test program for the unit connected, then proceed to test it.

The prototype tester has plug-in facilities for up to seven different measurement devices, one readout instrument and a termination unit containing signal sources and loads. These are all arranged for automatic setup in accordance with the instructions coded into the punched tape by engineers beforehand.

Complete performance evaluation of a unit takes about 7 minutes, which includes recording of actual values on a Clary printer. These must be compared with tolerance limit data to determine whether the unit is passed or set aside for troubleshooting.

Conclusions. The key to success in all types of mechanized electronic production lies in flexibility—the ability to change over quickly from one wiring design to another with a minimum of down time on the equipment.

There is danger in the temptation to overproduce once an automatic line is running smoothly. New designs are essential for maintenance of a continuing, unsaturated market. More than ever before, sales and market research departments must team up with engineering and production in planning the optimum economic time schedule for their firm on its path to mechanization in production.

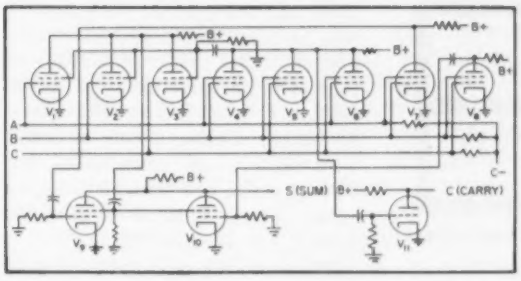


FIG. 1—Typical binary adder developed from pentode tubes

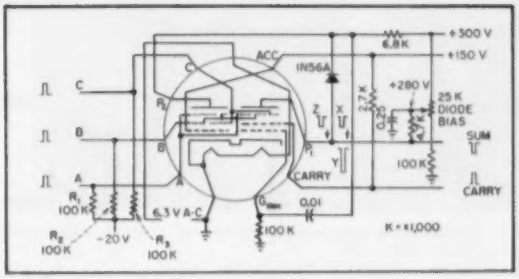


FIG. 2—Binary-adder tube replaces array of Fig. 1

Binary Adder Tube for High-Speed Computers

SUMMARY —— Special-purpose electron tube has all required binary-addition functions self-contained in single envelope. Outputs have sufficient power to insure sharp rise times with fast operational speeds and will directly drive similar following tube without additional amplification

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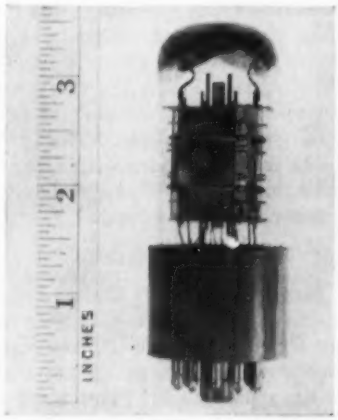
THREE-INPUT binary adders are conventionally developed by combining a number of simple elements or gates which have the required functions: and; or; inhibitor. This generally results in a complicated circuit of tubes, diodes or relays.

A typical adder developed from pentode electron tubes is shown in Fig. 1. This makes an excellent adder. However, the complete array must be repeated for each digital place to be added causing the number of components to become large, especially in the case of a several-place parallel binary adder.

All of the functions of the array of Fig. 1 may be accomplished in the single BG2 binary-adder tube illustrated in the photograph.



Experimental tube is sealed in T-9 bulb with 11-pin neosubmagnal base

A schematic of the tube structure and associated circuit is given in Fig. 2.

The mount structure consists of a central flat cathode surrounded by two half sections of grids and plates.

Three grid inputs, A, B and C, are internally connected to control grids in both halves of the tube. These grids are externally biased to cutoff through grid resistors R_1, R_2 and R_3.

Two outputs are provided. Plate P_1 produces a negative sum pulse

FIG. 3—Inhibited sum pulses and through carry in sample addition (A); sum pulses in sample addition (B)

in the event A, B or C is opened by a positive signal. The carry output produces a positive signal identical to the input signals, in the event any two or all three of the inputs are opened. During a double coincidence, however, no sum signal is produced. On a triple coincidence, both sum and carry signals are produced.

Operation

In the left half of the tube, as shown in Fig. 2, there is an accelerator grid which plays no part in the dynamic action. Following this is a set of three compound control grids so arranged that no electrons are gated to P_2 unless there is a double or triple coincidence of inputs on grids A, B and C. The output signal developed on P_2 is different in these two cases. On any double coincidence, one third of the grid area is opened, which produces a 20-volt negative signal on plate P_2.

On a triple coincidence, the entire grid area is opened, producing an approximately 60-volt negative signal on P_2.

Either of these two signals is sufficient to cut off completely inhibitor grid G_{1sh} in the right half of the tube. These signals are shown on the feedback loop from P_2 to G_{1sh} as waveforms X and Y and enter G_{1sh} through the blocking capacitor. These signals are also offered a path from P_2 to P_1 across the 1N56A diode. However, the positive end of this diode is biased 20 volts negative with respect to the no-signal voltage on P_2. The small signal X from P_2 cannot cause any potential change on the P_1 or sum output since it does not exceed the bias. The large 60-volt signal Y is able to override this bias resulting in a negative difference signal Z on the sum output.

Grid G_{1sh} is biased to cathode potential and is therefore normally conducting. Following this grid is an accelerator element which is connected to a high positive voltage through a 2,700-ohm load resistor. This is the carry element. It draws current in the normal condition and hence is negative with respect to B+. Following the carry element are three signal grids, internally connected to the ABC inputs, which are normally cutoff.

Electrons which drift through the carry element are gated to P_1 if any of these grids are opened. Thus any single coincidence on A, B or C will produce a sum signal on P_1. A double or triple coincidence will also tend to produce a signal on P_1 except that the negative signal produced on P_2 inhibits the electron flow by cutting off G_{1sh} as has been previously described. Thus no sum signal is produced on P_1 at any other time than on a single coincidence.

Since a sum signal is required on a triple coincidence input and this is prevented from forming directly on P_1 because of the inhibiting, it is derived as the signal Z across the diode as described. When G_{1sh} is driven negative on either a double or triple coincidence the carry element ceases to draw current and goes strongly positive. This produces an amplified positive carry pulse capable of directly driving another adder tube input.

Characteristics

Since this tube is a digital device operating only in the regions of cutoff and saturation, the important qualities are clean cutoff and high electron perveance. Since there is no requirement that this be a small-signal device, a reasonable input pulse amplitude of 20 volts positive was selected as an operating goal and all signal grids were adjusted to give cutoff values of −12 to −15 volts. The inhibitor grid has a somewhat sharper cutoff at about −10 volts which contributes materially to the rise time of the carry pulse. This section has an available gain factor of about 30.

The carry element acts not only as an accelerator but as the output element of the most important signal from the tube. This has been designed to dissipate continuously about 2½ w at a current of 15 ma.

Currents to plates P_1 and P_2 are approximately 3 ma. The static accelerator element ACC draws approximately 10 ma or 1.5 watts and is designed to dissipate this power continuously. A 6.3-volt, 0.8-ampere heater is used.

In a cascaded parallel-adder system the accumulation of delay in the carry is inherent and cannot be eliminated. This is so regardless of the components used in the adder. The delay arises from the fact that whereas the inhibitor signal and the sum signal are generated simultaneously by the input signals, the inhibitor signal must take the time to charge another grid before the sum signal can be shut off. This action generates the carry which in turn must charge another grid input in the next stage. Thus there are two delays in series at each stage. If this carry must generate another inhibitor signal and carry in the second stage, it is now delayed by a factor of 4.

Delay Spikes

The delay appears on the sum outputs as a leading-edge spike. Its width at any given output depends on the following factors: (1) the inherent rise time of the inhibitor system; (2) the inherent rise-time of the carry system; (3) the number of previous stages a carry has traversed.

The spike on the first 2^0 stage will always be small, since only the first factor is of consequence. On any succeeding stage it may be the same or some greater width up to (1) + (2) + (3) n, where the nth tube in n stages will be the worst case in certain additions, but in others will

be no worse than the first sum output.

An example of this widening spike during the progress of a carry through several stages is shown in Fig. 3A for a worst case in adding the binary 15 + 1. Note the proportionate narrowing of the carry pulse in the 2^4 place.

Another example of addition is shown in Fig. 3B, in which a carry resulting from the addition of addend and augend pulses in the 2^1 place generates the sum signal in the 2^2 place.

The measured carry delay with the type BG2 tubes and recommended circuit constants is about 0.3 μsec per stage, maximum. This would result in a worst-case spike of approximately 3 μsec in a ten-stage adder.

In the case of serial addition, as shown in Fig. 4A, there is no accumulation of carry delay. The very slight delay due to the first and second factors mentioned above can be partly compensated by slightly overdelaying the carry signal in the feedback path. The sum outputs will have somewhat narrower spikes than even the best case of parallel addition. This should contribute greatly to the ultimate speed.

This tube was designed specifically to operate in a several-stage a-c coupled parallel adder similar to the circuit in Fig. 4B. In this setup it was found to work at pulse rates up to 100 kc in a four-stage adder. However, if a larger number of stages were used the speed would be reduced to the point where the worst-case spike could be differentiated from the sum pulse.

In a serial addition application, such as shown in Fig. 4A, a considerably faster operational speed can be obtained.

Applications

There are some other logical functions aside from straight binary addition to which this tube may be adapted. One of these is the two-input Boolean adder or anticoincidence detector. For this application the bridging diode and carry resistor are not needed and the third input grid is biased permanently to C−. The sum plate, P_1, will give the same outputs on $A = 0$ and $B = 0$ as on $A = 1$ and $B = 1$. Only the anticoincidence of A or B gives an output. Simultaneously if desired, the carry output could be used to separate the positive (11) coincidences and the negative (00) coincidences.

Another function may be added with a fourth input on G_{inh}. By biasing this grid to cutoff by removing the feedback loop from P_s and applying a positive signal D, sum outputs occur on coincidences of any ABC inputs with D, but not on any ABC coincidences without D, and not, also with D alone.

The tube could also be used as an ABC coincidence detector by feeding the P_s signal to G_{inh} through a biased diode. This bias should be such that the small double-coincidence signal from P_s will not cut off G_{inh} but the much more negative triple-coincidence signal will. The carry output would then give a signal only on an ABC coincidence. This signal will be in phase with the input signals.

Some interesting flip-flop and oscillator circuits can be designed around this tube. Since the carry output is in phase with the signal input, this may be fed back to one of the inputs with either d-c coupling to give flip-flop action or a-c coupling to give oscillation.

The following is an example of a different logical function which can be done in this way. Suppose some event could only be made to occur by the arrival of two elements A and B. Once started, however, the presence of either A or B would maintain the event and only the absence of both would cause it to cease.

This can be done with the BG2 tube by feeding back the carry into an input, say the C input. Direct-current coupling is assumed on both this feedback and the P_s-G_{inh} feedback loop. Since the carry element is normally negative, grid C will remain closed. To form an inhibitor signal on P_s it is necessary to open two inputs. Therefore, in this condition, nothing except a sum output will happen on either A or B inputs. However, if A and B are both activated, the carry is formed, which now opens input C. Thus if either A or B drops out, there are still two grids open and the flip condition will maintain. However, if both A and B drop out, the system will reset to the original condition and maintain that way until another A-B coincidence.

This development has been sponsored by an agency of the Department of Defense.

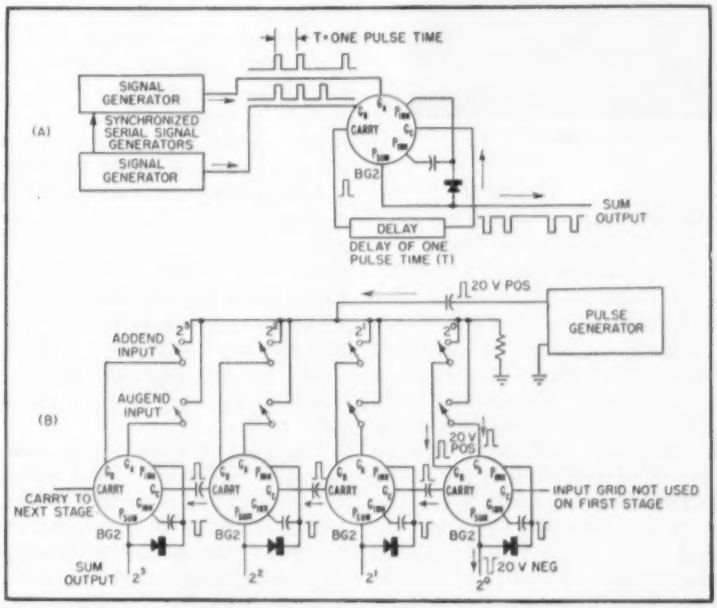


FIG. 4—Demonstration serial adder (A) and parallel adder (B), use BG2 binary-adder tubes. Serial adder can have operational speed in the region of 1 mc

Electromagnet Removes

SUMMARY —— Multiple-coil electromagnet driven by 25-kw amplifier at 3 to 12 kc has been used by medical experimenters to pull brass, lead, aluminum or copper fragments from cat-eye vitreous in trays. Indications are that this can be developed into a device for use on human eyes

Electromagnet for nonferrous metals is designed as aid to eye surgery

EYES penetrated by particles containing sufficient magnetic material are usually saved by the ordinary electromagnet; eyes penetrated by fragments of nonferrous metals are commonly lost.

Development of an electromagnet for nonferrous metals, first operated on 60 cycles and used to pick up relatively large objects such as silver coins and copper rings[1-3], resulted in a study of possible application to eye surgery. Tests were made on bits of brass, lead, aluminum and copper suspended by threads, using an oscillator and a 30-watt amplifier.

Results were promising but indicated need for relatively high power over a considerable frequency range. Facilities for testing at two kilowatts were provided. Using that equipment a 2-mm copper-wire clipping was moved about 3-mm through cow-eye vitreous in a tray.

The Office of the Surgeon General of the Army became interested when it developed that about 25 percent of the numerous eye injuries in the Korean conflict due to metal fragments involved nonmagnetic metals.

The new electromagnet has been developed[4] to a point at which particles of copper, aluminum and magnesium have been extracted from the eyes of experimental animals using a water-cooled electromagnet supplied from a 25-kw amplifier at 5 to 10 kilocycles.

Principles

When a simple coil carrying alternating current surrounds a closed conductor or a short circuited coil and a conducting object is adjacent to the inner member (see Fig. 1,) currents of substantially like phase are induced in the object and in the inner fixed member setting up attraction forces between them.

By proper configuration and geometry there is an attraction zone approximating a cone with its base in the surface of the structure. A conducting object situated so that the principal induced current paths lie within this region will be attracted by predominance of the attractive force over repulsion. Outside this zone there is repulsion.

This simple form is shown in Fig. 1 in which the attraction zone for large objects is shown in dotted lines. The model shown in the figure has a central magnetic core filling, an opening in the attractor and also an intermediate core between the attractor and field coil which intensifies the field of the main coil.

The zone of attraction is determined by configuration and certain adjustments and is not increased by increased power. Within this zone, however, effective pull is increased by increase of power

When both field-producing elements are windings energized by

Nonferrous Metals

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direct connection to the source but reversed with respect to each other, and the coils are axially short, a middle region of attraction bounded by inner and outer regions of repulsion is formed. This is illustrated in Fig. 2. Two coils *A* and *B* are shown, one having twice the diameter of the other. Note the conducting ring of the same diameter as the inner coil. The curve in Fig. 3 shows the variation of force with distance from the structure on a conducting ring or disk.

For greater effectiveness it is necessary to control both the phase and magnitude of the current in the attractor.

Capacitors are used when working in the audio or higher frequency range. The magnitude of the attractor current is controlled by having a supplementary winding at the rear of the main field coil connected in series with the attractor, usually boosting. Figure 4 is a diagram of elements with the conducting object depicted as a single short-circuited turn near the attractor. With strong feed to the attractor the construction shown in Fig. 1 can also be made to show an inner repulsion range.

For effective work on particles, frequencies in the audio range or higher are needed. To move objects through a resisting medium considerable power is also required.

Power and Controls

The power plant is rated at 25 kw from 3 kc to 12 kc and the useful range can be extended to 50 kc by changing the driver output transformer. The power apparatus consists of a rectifier, a driver and a power amplifier as shown in Fig. 5.

The power level of the large amplifier output is set by the output control of a variable-frequency oscillator which fixes the voltage impressed on the input to a 20-watt preamplifier.

Pulsing is controlled by a footswitch at the operating stand through relays in the output circuit of the preamplifier (which has a permanent protective load) and a time-delay relay. The on-time is adjustable from $\frac{1}{10}$ second to several seconds and the pulse is stopped at any time by releasing pressure on the foot switch. The off-time insures proper cooling.

Coil Design

Dominant features in design for eye surgery are: the required range of action; shape of the coil to be accommodated to the human head; proximity-effect losses in the coil; limited use of iron in the magnetic circuit and necessity for leaving a large opening in the main coil for the attractor.

The surgeon can rotate the eye so that in general it is unnecessary to work at more than 12 mm, which is half the diameter of the eye. Most of the volume of the eye is within 7 mm of the surface so that an effective pull at this distance can be very useful. A taper is required, particularly on the nasal side and this increases the difficulty of producing a strong field at a distance from the surface of the structure.

In a given coil outline the aim is to arrive at an arrangement that will allow adequate cooling, have low impedance and give a high value for the product of flux and

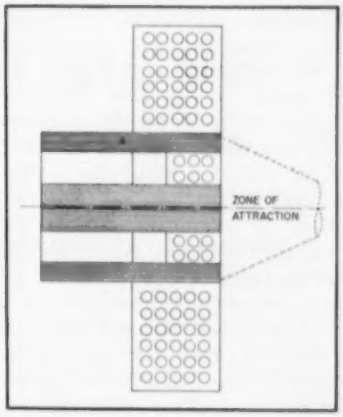

FIG. 1—Simple form of electromagnet showing attraction zone

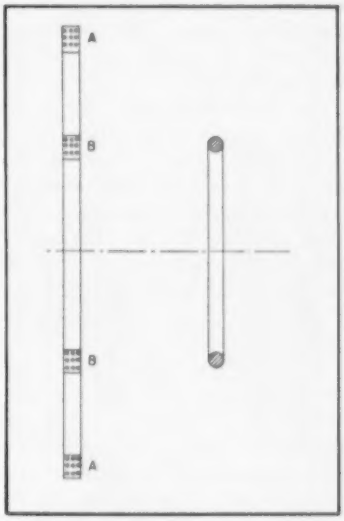

FIG. 2—Two coils *A* and *B* are shown at left with conducting ring at right

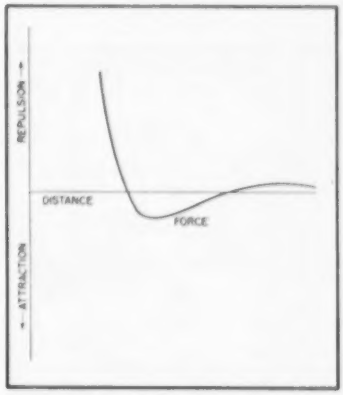

FIG. 3—Plot of force versus distance on a conducting ring or disk

reversed gradient at points in the working zone. Losses due to proximity effect are great and the spacing is worked out to give the best compromise between this factor and a high space factor.

Within limits, the higher the frequency the greater the pull. Heating of the object also increases with frequency. Failure of the Q of the coil, of a particular outline, to rise proportionately with increase in frequency signals the point of diminishing return for frequency increase. Above 10 kc the losses become severe; at 10 kc a Q of 12 to 14 is considered good.

Material used for the partial magnetic circuit is Armco Trancor 0.002-in. high-silicon steel which is worked at or near saturation. A thin layer of this iron as an intermediate core is helpful even at maximum power. The placement and thickness of the intermediate core are critical.

The electromagnet structure though tapered is relatively blunt compared to the pointed instrument used for iron and does not give the surgeon a clear view of his working field and so the central core is often omitted or reduced. This leaves a peep hole 3 to 5 mm in diameter through which the incision can be seen.

A probe type construction was investigated in which the attractor was at first a small sleeve or perforated disk of copper or brass 4 to 8 mm in diameter. This was later replaced by silver tubing for water cooling. A thin jacket of high-silicon steel surrounding the attractor was found beneficial. This probe extended about $\frac{3}{8}$ inch from the face of the coil. The probe form has a disadvantage in that the range is small with a small diameter probe.

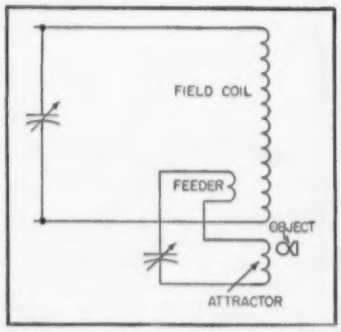

FIG. 4—Simplified circuit for controlling the phase and magnitude of current in the attractor

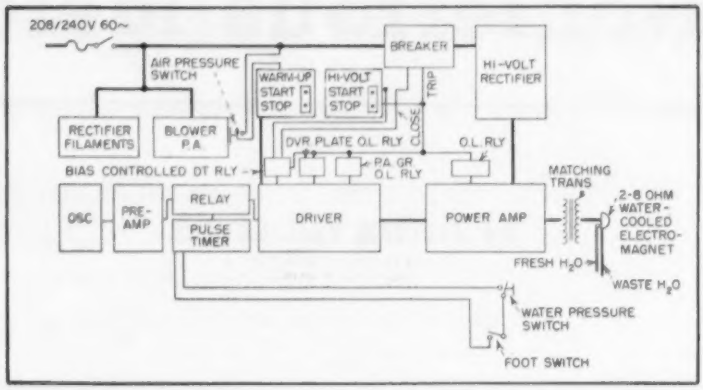

FIG. 5—Elements of sonic power unit. Power amplifier employs six 3X2500F3 tubes operated class AB_2 push-pull, parallel

Fields and Forces

A tapered coil, 4-in. o-d., $1\frac{1}{4}$-in. i-d., wound with 0.06-in. by 0.04-in. copper tubing, using 8,000 ampere-turns, without the intermediate core and with attractor open circuited, creates a field of 2,000 gauss at 8.3 kc at the attractor aperture and 1,000 gauss at 1 cm out on the axis. The pull on a 2-mm particle of copper in this arrangement but with intermediate core and $\frac{3}{4}$-in. attractor is measured at 20 times gravity at 7 mm from the attractor aperture and off center where the pull is great.

The vitreous jell which fills the posterior chamber of the eye is a tenaciously resisting medium. A pull of about 5 g is required to move a 2-cu-mm piece of copper through fresh vitreous from a cat eye but after such a piece has been imbedded for two weeks in a living eye a pull of 100 g may fail to move it. The required force as expressed in g's is inversely proportional to linear dimensions.

Apparently there are variable factors, for some objects sink in the vitreous while others of the same size and composition remain in place. Difficulty of extraction of an object increases markedly in a matter of days or even hours due to the inflammatory process which embeds the object and sooner or later destroys the eye. Copper is the worst offender in this respect, followed by brass and aluminum. Copper is much easier to attract than brass because of greater conductivity but the more rapid production of fibrinous coating on copper tends to put the two materials on a more equal footing.

The maximum force of 20 g developed at a depth of 7 mm in the eye on a 2-mm piece of copper using a tapered coil is about half the force developed on soft iron by one of the d-c hand magnets commonly used in eye surgery. The force is less on smaller objects and on those of higher resistance but it is sufficient to move a 1.6-mm piece of brass through fresh vitreous.

No trials have been made with human eyes but the near-term outlook seems to be favorable for objects 1 mm or greater in smallest dimension, especially those of copper and aluminum, if early operation can be provided.

Much credit is due to J. C. Wright, Signal Corps. The program has been carried out under Medical Research and Development Contract No. DA-49-007-MD-258 in cooperation with the Ocular Research Unit of Walter Reed Army Hospital.

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(2) Lovell, U. S. Patent, 2,400,869, May 1946.
(3) J. Harry King Jr., William Vail Lovell, Alfred A. J. Den, M. Noel Stow and William C. Owens, "The Extraction of Intra-ocular Nonferrous Metallic Foreign Particles—Preliminary Experiments with a New Electronic Magnet".

Automatic Recorder for Complex Impedances

SUMMARY — Oscilloscope recorder for barium-titanate-transducer research plots impedance from zero to 1,000 ohms as a function of frequency over a range from 100 cps to 1 mc. Circuit can be modified for use as a phase meter over wide frequency range

By HAROLD M. SHARAF

Laboratory for Electronics Boston, Mass.

IN the study of electrical properties of barium titanate transducers an efficient method of measuring the characteristics parameters is needed. The automatic impedance plotter described in this article records the various electrical parameters as a function of freqency. The instrument is of the continuously recording type and has an accuracy of 2 percent.

Square-Law Circuit

In the basic square-law multiplier circuit shown in Fig. 1, one signal, $e_2 \cos \omega t$, is fed to both tubes in phase, while the other signal $e_1 \cos (\omega t + \phi_1)$ drives both tubes 180 deg out of phase. If the plate current of a triode tube is represented by a power series of the form $i = a_0 + a_1 e_g + a_2 e_g^2 + - - -$ where all factors above a_2 are to be considered insignificant, the integrated output of this stage is $e_o = a_2 e_1 e_2 \cos \phi_1/\pi$, where ϕ_1 is the phase angle between the two input signals. If $e_2 \cos \omega t$ can be considered to be a reference voltage, then the output of the multiplier is seen to be $e_{o1} = Ke_1 \cos \phi$. If the reference voltage is shifted in phase by $\pi/2$, this output will be $e_{o2} = Ke_1 \sin \phi$.

One recording instrument which possessed a nominal accuracy of 5 percent and a maximum frequency response of 500 kc was constructed with the aid of this multiplier. The block diagram of the system is shown in Fig. 2.

The reference voltage for the real part of the complex impedance is taken directly from the source; that for the imaginary part is taken from an integrator network that provides an 89-deg phase shift at the lowest frequency used. To provide an adequate constant voltage source for the sin ϕ reference chassis, a parallel form of agc was used to eliminate the need for an infinite-gain amplifier. With this parallel form of circuit, a nonlinear agc voltage was developed that kept the output of the reference voltage constant to better than 1 percent over the entire frequency range. The reference voltages are then used to drive the cathodes of two multiplier circuits shown as the sin ϕ and cos ϕ channels.

The signal voltage itself is amplified and coupled to the grids of the multipliers. This signal voltage is generated either by taking the voltage developed from the unknown to ground or across a 1-ohm resistor in series with the unknown.

In the first case, a large resistor is placed in series with the source. This has the effect of transforming the voltage source into a current

Rack-mounted complex impedance recorder. Impedance-frequency plot is displayed on oscilloscope at left

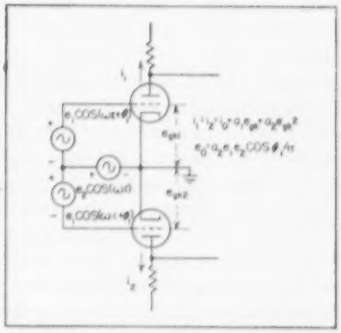

FIG. 1—Basic multiplier circuit used in recorder covering a frequency range up to 500 kc

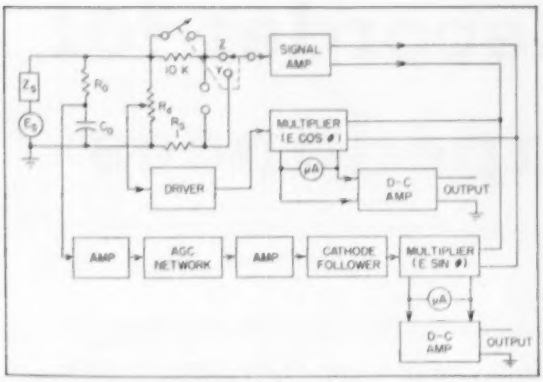

FIG. 2—Use of agc network in complex impedance recorder eliminates need for infinite-gain amplifiers

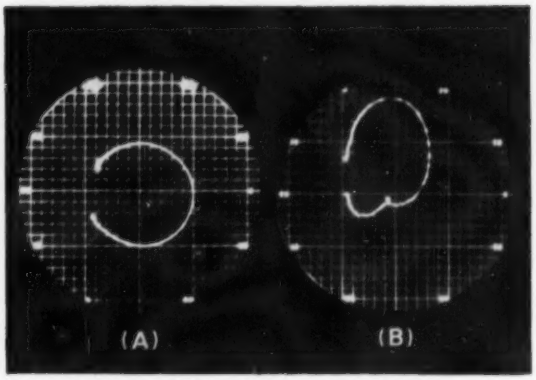

FIG. 3—Impedance pattern for series-resonant circuit (A) and for barium-titanate transducer coupled to a zero impedance load (B)

source. As the current is practically constant for $R >> Z$, the instrument will record an output proportional to the impedance of Z. When Z approaches $0.01R$, the input leads are shifted to record the magnitude of current through Z or Z is recorded as an admittance.

In this manner, an impedance range of zero to infinity can be recorded on a finite meter scale. When the instrument is used as an admittance meter, the source impedance, Z_s, must be less than 1 percent of Z or proportional inaccuracies will be obtained. For this application, a power amplifier is well suited as it can be used in conjunction with a divider network to reduce the effective output impedance of the amplifier. Looking back into the divider, the maximum output impedance is equal to the value of the resistor that the output voltage is developed across.

Multiplier Voltage

The multiplier output voltage is taken directly from the plates of the triodes and used to drive an indicating meter. The meter itself provides the necessary integrator time constant. A small cathode resistor in the multiplier adjusts this stage to compensate for any small plate-voltage unbalance. The differential plate voltage is also coupled through a d-c differential amplifier where it is converted to a single-ended output and then connected to an oscilloscope for display purposes. A variable voltage is placed in series with the scope output to allow full-scale deflection of small re-entrant loops situated about various impedance levels.

The instrument has one drawback, maintaining the accuracy of the square-law multipliers. The square-law characteristics are obtained by superimposing the $i_b e_g$ curves of two triodes. The composite curve is subject to error caused by both mechanical and electrical variances in this circuit.

With careful balancing of all circuit components, a maximum deviation of 2 percent from true square-law operation was encountered for a reference voltage swing of 2 volts. The signal level was approximately 0.2 volt. For the instrument as a whole, an accuracy of 5 percent was obtained over the entire frequency range. For a small deviation, say 25-kc, the accuracy approached 2 percent. A typical pattern of a series-resonant circuit is presented in Fig. 3A with F_o = 170 kc, and a sweep-frequency from 100 to 500 kc.

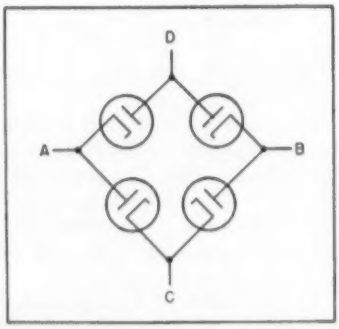

FIG. 4—Diode bridge circuit eliminates dependence on tube characteristics required in square law multiplier

Figure 3B shows a typical pattern obtained from a barium-titanate hemisphere. The simplest equivalent circuit of a barium-titanate transducer is a parallel tuned circuit coupled to some form of load. If the driving current to this circuit is held constant, the input voltage will describe a closed loop as a function of frequency. For the case where the load impedance is zero, the circuit will degenerate to the case depicted in Fig. 3A. As the equivalent circuit becomes more complex, small re-entrant loops will appear in the closed loop and the loop may become elongated along one of the major axes. In plotting the dynamic impedance continuously, it is a simple task to discern the points of B_{max}, G_{max}, re-entrant loops, etc. The frequency and magnitude of B_{max} and G_{max} can be obtained almost instantaneously from this type of display.

Diode Bridge

To reduce the dependence of accuracy on tube parameters, a novel form of circuit was evolved for use in this instrument. Consider the basic bridge circuit depicted in Fig. 4. If a current is forced from C to D then the impedance level from A to B is approximately equal to that of the forward resistance of a single diode. If this current, henceforth called a switching current, is removed, then the impedance level will be equal to the back impedance of a diode. If point B is grounded and a voltage $E \cos \omega t$ is applied to point A through a resistor large in comparison to the forward re-

sistance of the diodes, yet small in comparison with the back resistance then the voltage at point A will either be equal to $E \cos \omega t$ or zero depending on the state of the switching current. The diode bridge is balanced to better than 46 db in the conducting direction. Balance in the reverse direction can be as low as 20 db as the associated bridge circuits effectively add 30 db of balance. The maximum amplitude of voltage that can be switched is approximately 100-volts peak to peak. The frequency of the switching current can vary from d-c to approximately 1 mc.

Phase-Shift Effect

Consider now the effect of a phase shift between the switching voltage and the switched voltage, $E \cos \omega t$. If the two voltages are in phase, only the positive or negative half cycle of $E \cos \omega t$ will be developed at A during any one period and the d-c output voltage at E will be $e_o = KE/\pi$ where K is the bridge efficiency. The sign depends on the bridge configuration.

If $E \cos \omega t$ is shifted by 180 deg, then the output voltage will reverse sign. Should the phase shift be 90 deg, then the output voltage will be equal to zero.

This circuit has none of the disadvantages of the square-law multiplier with the possible exception of the initial diode balancing. With reference to Fig. 2, the stringent requirements of the constant voltage amplifier were relaxed as the magnitude of the switching current can be varied within certain physical limits. A 4 to 1 change in switching current can be tolerated. The power amplifiers used to drive the cathodes of the multiplier were replaced by voltage amplifiers with a large saving in B+ power. The balanced push-pull amplifiers used to drive the multipliers were replaced with single-ended amplifiers.

As the output of the diode bridge is single ended and the voltage levels are fairly high, the output of the bridge can be used to drive the recording oscilloscope and meters directly without an intermediate d-c amplifier.

Measurements have shown the output of the bridge to be linear to 1 percent over a 40-db voltage range. The phase response is proportional to any phase difference $\cos \theta$ within a few degrees. Final figures are not yet available in the 100 kc to 1 mc range due to a lack of adequate instruments.

Using this system of detection, an instrument, shown in Fig. 5, was constructed covering a frequency range of 100 cps to 1 mc in four bands. An impedance range of 0 to 1,000 ohms can be recorded directly, while the range of 1,000 ohms to infinity is recorded as an admittance.

If the signal amplifier is modified slightly to produce square waves insensitive to amplitude variations the instrument could be used as a phase meter over a large frequency range.

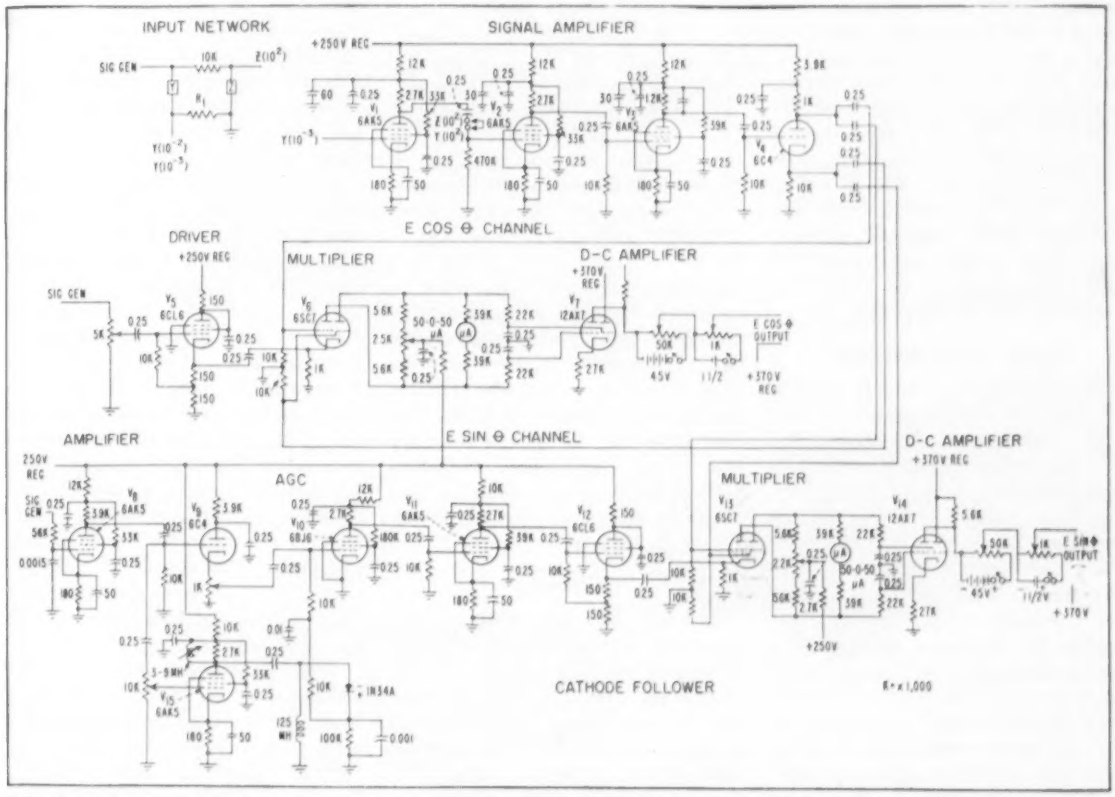

FIG. 5—Circuit of complex impedance recorder. Input network is connected as series or parallel load depending on impedance level of source

Amplifier for Fast Rise-Fall Pulses

SUMMARY — Pulse amplifier of high efficiency gives good power economy and amplitude control. The output pulse rises 100 volts in about 0.1 microsecond and falls 100 volts in approximately 0.2 microsecond with negligible pulse droop during pulse time

By CHARLES R. DEMING

Research and Development Laboratories
Hughes Aircraft Company
Culver City, California

POWER ECONOMY is one of the problems often associated with the generation or amplification of a pulse having a fast rise and fall. Low stand-by current is especially desirable in pulse circuits of low duty cycle where the average power may be small compared to the peak power. However, during the pulse, the load may require high currents. Also, during the fast rise the current from the generator to the stray capacitances of the load may be quite high. During the fall, current into this generator may be many times the quiescent value. Amplitude control, where the height of the output pulse may need to be accurately known, is still another problem.

Design Considerations

The cathode follower is capable of supplying high currents for positive-going output voltages, but the current for negative-going output voltages is limited by the cathode load resistor. A plate-loaded amplifier is capable of supplying the heavy currents for fast negative-going signals, but the current for positive-going outputs is limited by the plate resistor. The load resistance in both cases should be made large to minimize power loss, although this is achieved at the expense of response in the unfavorable direction of output current.

The unfavorable direction is a negative-going waveform for a cathode follower and positive-going waveform for a plate-loaded amplifier. A two-tube circuit may be used in which a cathode follower has another tube as a load. The load tube may be driven to lower the output impedance. Negative voltage feedback applied to the load tube will reduce the output impedance still further.

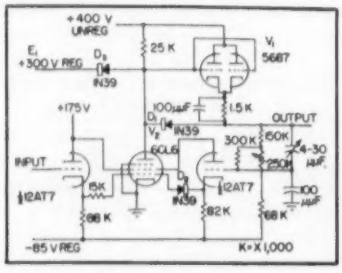

FIG. 1—Positive-pulse output circuit with amplitude control

Circuit

In Fig. 1, tube V_1 is both sections of a 5687 connected in parallel and V_2 is a 6CL6. The two halves of a 12AT7 are each connected as cathode followers to provide suitable isolation for the input and amplitude control networks. Small capacitors located at the output are for frequency compensation in the amplitude control circuit.

With no signal the input is at ground potential. The output voltage level is held at the base-line value of the pulse by negative feedback through D_2, which applies the appropriate bias to V_2. The negative input pulse cuts off V_2. The plate voltage of V_2 and the grid of cathode follower V_1 rise to E_1. The cathode potential and accordingly the output voltage of V_1 rise to E_1 and stay there so long as the input pulse maintains V_2 at cutoff.

When the input voltage returns to zero the grid of V_2 also becomes zero since diode D_2 is still nonconductive as a portion of the positive output pulse is applied to the cathode of the diode. At zero bias V_2 conducts heavily through diode D_1 from the load quickly lowering the voltage at the output. As the output reaches the base-line of the pulse, the cathode of D_2 reaches zero volts. Further downward voltage applies bias to V_1 through D_2 to limit the negative-voltage excursion to the quiescent level, ending the pulse. The output of this circuit rises 100 volts in about 0.1 microsecond and falls 100 volts in about 0.2 microsecond.

The circuit was built into a cathode-ray tube test set at the Electron Tube Laboratories of Hughes Aircraft Company in Culver City, California. Credit is due to W. J. Cronin, N. Chalfin, and L. Toy for their valuable contributions.

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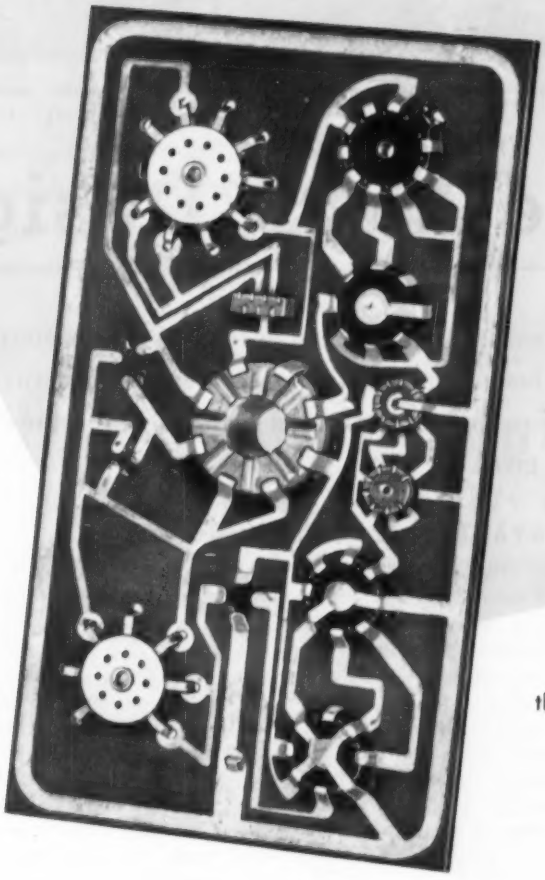

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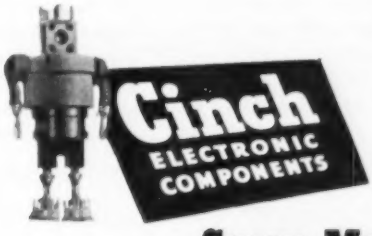

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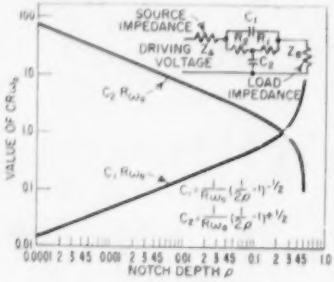


FIG. 1—Capacitor value curves

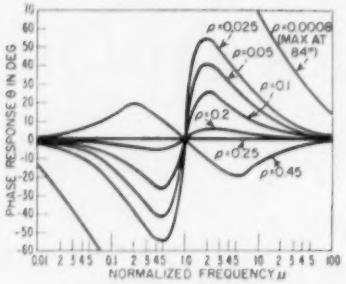


FIG. 2—Phase response curves

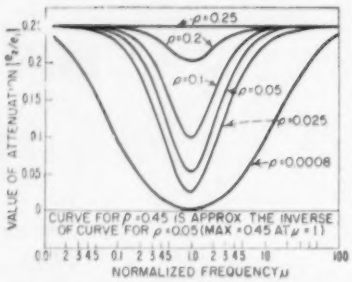


FIG. 3—Attenuation response curves

Notch Network Design

SUMMARY —— Charts and simple synthesis procedure speed determination of component values for loaded bridged-tee network operating between equal impedances, for any desired notch depth and frequency. Attenuation and phase response are also given

By C. J. SAVANT, Jr. and C. A. SAVANT

University of Southern California
Engineering Center
Los Angeles, Calif.

SERVOMECHANISM design and equalization often call for amplitude attenuation at a particular frequency. This requirement, as with noise filters and many other applications, can often be satisfied by use of a bridged-tee notch network.

Practically, these requirements are usually reduced to approximately a ten-to-one ratio of load impedance to network and driver impedance. But even this simplification cannot be accomplished in many cases without undue circuit complexity.

Design of the R-C bridged-tee network in Fig. 1 involves specifying the notch frequency ω_o, the notch depth ρ expressed as the gain of the network at the notch frequency, the source impedance Z_A and the load impedance Z_B.

The parameter for notch width n need not be considered in the synthesis procedure presented here because notch width is minimized.

In this design procedure the source and load impedances are taken to be equal. This advantageous choice permits the cascading of a number of networks all of the same impedance level.

Design Procedure

As the first step, enter Fig. 1 with the notch depth ρ and read the values of $C_1R\omega_o$ and $C_2R\omega_o$. Now set $R_1 = R_2 = Z_A = Z_B = R$ and calculate C_1 and C_2. If necessary, the source impedance can be made equal to the load impedance by padding.

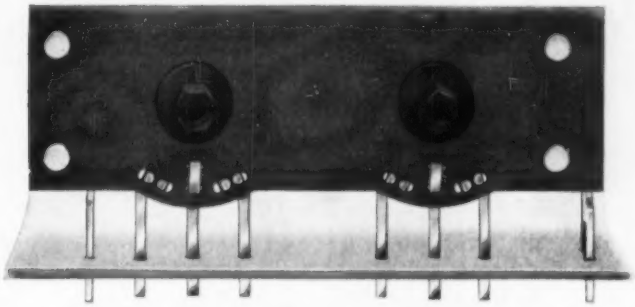
Example: $Z_A = Z_B = 100{,}000$ ohms, $\rho = 0.05$ and $f_o = 20$ cps. From Fig. 1, $C_1R\omega_o = 0.33$ and $C_2R\omega_o = 3.0$. Now $Z_A = Z_B = R_1 = R_2 = 100{,}000$ ohms, $\omega_o = 6.28 \times 20 = 125.6$ radians per sec, $C_1 = 0.33/100{,}000 \times 125.6 = 0.026$ μf and $C_2 = 3/100{,}000 \times 125.6 = 0.24$ μf.

The attenuation and phase response for the bridged-tee network of Fig. 1 are plotted in Fig. 2 and 3 as a function of the normalized frequency $\mu = \omega/\omega_o$. The amplitude curves have the same symmetrical appearance and form as in the unloaded case[1] with two exceptions: (1) The d-c and infinite frequency gain is $\frac{1}{4}$. This means that the network acts as a four-to-one voltage divider at any frequency; (2) the minimum notch width becomes excessively wide for values of ρ over 0.025. The characteristics invert for values of ρ greater than 0.25 and the notch network changes from a band-reject to a band-pass filter.

REFERENCE

(1) C. J. Savant, Jr., How to Design Notch Networks, p 188, ELECTRONICS, May 1953.

MALLORY



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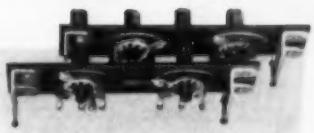

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Electrons At Work

Edited by ALEXANDER A. McKENZIE

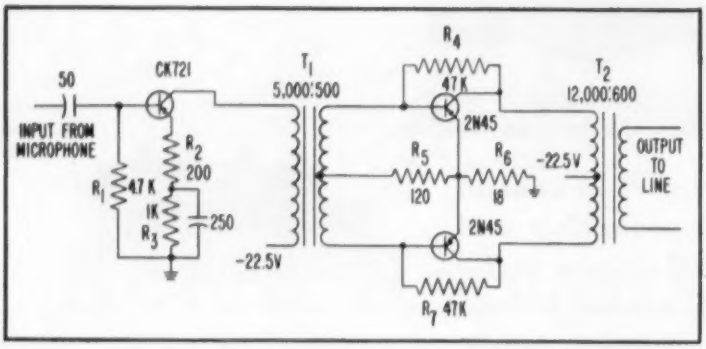

FIG. 1—Basic high-fidelity audio amplifier used as part of remote broadcast pickup unit having low power consumption

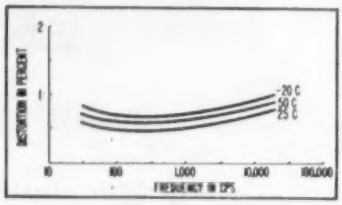

FIG. 3—Over the desired temperature and frequency ranges the transistor circuit has 50 mw output with less than 1-percent distortion

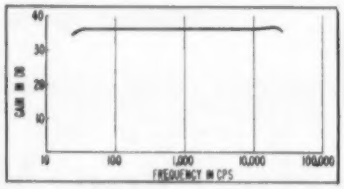

FIG. 4—Frequency response from 30 to 20,000 cycles is flat within ± 1 db

High Fidelity Transistor Power Amplifier

By ROBERT L. RIDDLE

Electrical Engineering Dept.
Pennsylvania State University
University Park, Pa.

LOW-POWER PORTABLE equipment finds greatest use for transistors. With them, it is possible to build a device that will deliver 50 mw and have a frequency response flat within ±1 db over a frequency range of 30 to 20,000 cps. At the same time the amplifier will have less than 1-percent distortion over this same frequency range. The amplifier may also be designed to be temperature stable over a range from −20 to 50 C.

The circuit of such an amplifier shown in Fig. 1 consists of two 2N45 transistors connected in class A push-pull for the power output stages and a CK721 transistor connected in grounded emitter as the driver.

The driver is a grounded-emitter class A amplifier in which the bias is temperature-stabilized over the range from −20 to +50 C. This d-c temperature stability is obtained by the biasing network consisting of resistors R_1, R_2 and R_3. The 200-ohm unbypassed resistor in the emitter lead supplies negative feedback, which compensates for changes in the transistor with temperature and thus holds the distortion of the driver below 1 percent over the frequency range 30 to 20,000 cps.

The power output stage consists of two 2N45 transistors connected in grounded emitter class A push-pull. The reason for using this configuration is to obtain 50 mw output and to reduce the total distortion in the output. This connection, owing to the phase relationships present in the output transformer, cancels out all the even harmonics.

The network of resistors R_4, R_5, R_6 and R_7 temperature stabilize the

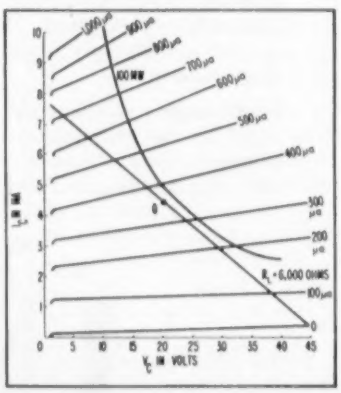

FIG. 2—Maximum allowable dissipation is shown by the 100-mw curve

amplifier over the desired range. At the same time resistors R_4, R_6 and R_7 supply negative feedback. Resistors R_4 and R_7 supply shunt type negative feedback that will lower the input impedance.

Series negative feedback, which will tend to increase the input impedance is supplied by R_6. The input impedance to the output stages is thus stabilized. The negative feedback also holds the distortion within limits over the temperature and frequency ranges.

Transformer T_1 with an impedance ratio of 5,000 to 500 has less than 0.2-percent distortion over the frequency range 30 to 20,000 cycles. The frequency response of the transformer is ±1 db over the range 30 to 20,000 cps. Transformer T_2 has an impedance ratio of 12,000 to 600 ohms and has the same requirements as transformer T_1 as to distortion and frequency response.

The operating point of the two 2N45 output transistors is shown in Fig. 2. The maximum allowable dissipation is shown as the 100-mw dissipation curve.

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- Oil Filled Condensers.
- Wire Harness and Resistor Board Construction.
- Power Requirements 105-125 volts, 50-60 cycles. Units operate up to 400 cycles.
- Terminations and locking type voltage control on rear of unit.
- AC, DC Switches, Fuses, and Pilot Lights on Front Panel.
- Color Grey Hammertone.
- Guarantee One Year.

To include 3" Current and Voltage Meters, Add M to Model number (e.g. KR 1-M) and Add $30.00 to the Price.
To include Dust Cover and Handles (for Table Mounting, Add C to Model number (e.g. KR1-C) and Add $10.00 to the Price.
To include Meters, Dust Cover and Handles, Add MC to Model number (e.g. KR-1MC) and Add $40.00 to the Price.
PRICES F.O.B. Flushing.

KEPCO Laboratories

KEPCO LABORATORIES

131-38 SANFORD AVENUE • FLUSHING 55, N. Y.

INDEPENDENCE 1-7000

125 ma. KR SERIES

MODEL	OUTPUT	VOLTS	CURRENT	REGULATION line 105-125v	REGULATION load 0 max	RIPPLE (RMS)	19" Rack Mount W	H	D
KR1 $90.	1	100-200	0-125 ma.	0.3 volts	0.3 volts	3 mv.	19"	7"	7½"
	2	6.3 AC	3 amp.	*	*				
KR2 $90.	1	200-325	0-125 ma.	0.2 volts	0.2 volts	3 mv.	19"	7"	7½"
	2	6.3 AC	3 amp.	*	*				

*AC Voltages unregulated.

300 ma. KR SERIES

MODEL	OUTPUT	VOLTS	CURRENT	REGULATION line 105-125v	REGULATION load 0 max	RIPPLE (RMS)	19" Rack Mount W	H	D
KR3 $180.	1	100-200	0-300 ma.	0.3 volts	0.3 volts	3 mv.	19"	7"	11"
	2	6.3AC	5 amp.	*	*				
	3	6.3AC	5 amp.	*	*				
KR4 $180.	1	200-325	0-300 ma.	0.2 volts	0.2 volts	3 mv.	19"	7"	11"
	2	6.3AC	5 amp.	*	*				
	3	6.3AC	5 amp.	*	*				

*AC Voltages unregulated.

600 ma. KR SERIES

MODEL	OUTPUT	VOLTS	CURRENT	REGULATION line 105-125v	REGULATION load 0 max	RIPPLE (RMS)	19" Rack Mount W	H	D
KR5 $240.	1	100-200	0-600 ma.	0.3 volts	0.3 volts	5 mv.	19"	10½"	13"
	2	6.3 AC	10 amp.	*	*				
	3	6.3 AC	10 amp.	*	*				
KR6 $240.	1	195-305	0-600 ma.	0.2 volts	0.2 volts	5 mv.	19"	10½"	13"
	2	6.3 AC	10 amp.	*	*				
	3	6.3 AC	10 amp.	*	*				
KR7 $250.	1	295-405	0-600 ma.	0.2 volts	0.2 volts	5 mv.	19"	10½"	13"
	2	6.3 AC	10 amp.	*	*				
	3	6.3 AC	10 amp.	*	*				

*AC Voltages unregulated.

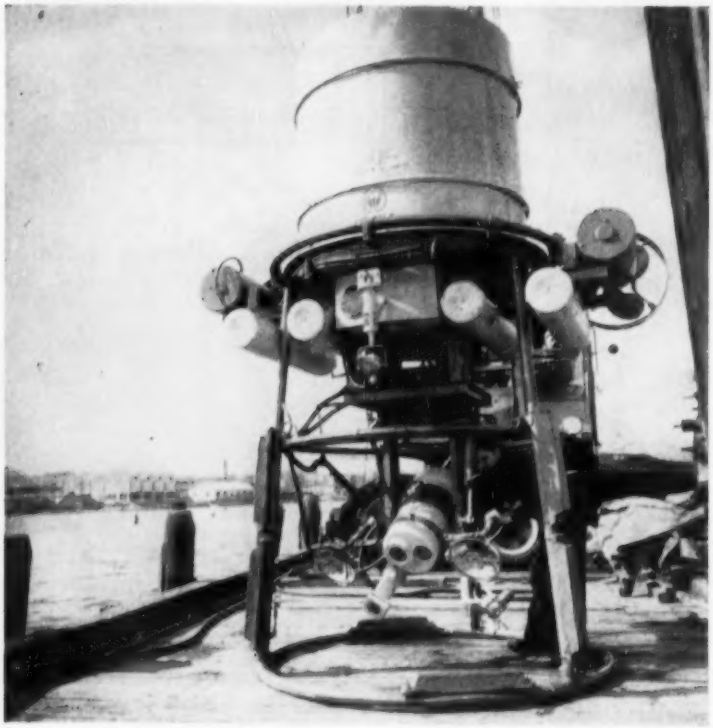
cuit will deliver 50 mw of power over the desired temperature and frequency ranges with less than 1-percent distortion, as shown in Fig. 3.

The frequency response is delineated in Fig. 4. Total gain of the driver and output stages adds up to 36 db.

The total power drain on the amplifier is 10 ma at 22.5 volts, or a total power of 225 mw. The total amplifier is operating with better than 20-percent efficiency.

The work described in this article was performed during the time that the author was employed at Collins Radio Co., Cedar Rapids, Iowa.

Underwater Television Camera Hovers Or Cruises



DEPARTMENT OF NAVY'S Bureau of Ships has successfully tested a new underwater television equipment (AN/SXQ XN-1) that permits complete surface control of the movement of the camera unit.

This development uses a new method of underwater depth control originated by the Bureau of Ships that is sufficiently responsive to permit hovering and cruising six inches above the bottom of the ocean without disturbing mud and silt that would reduce underwater visibility.

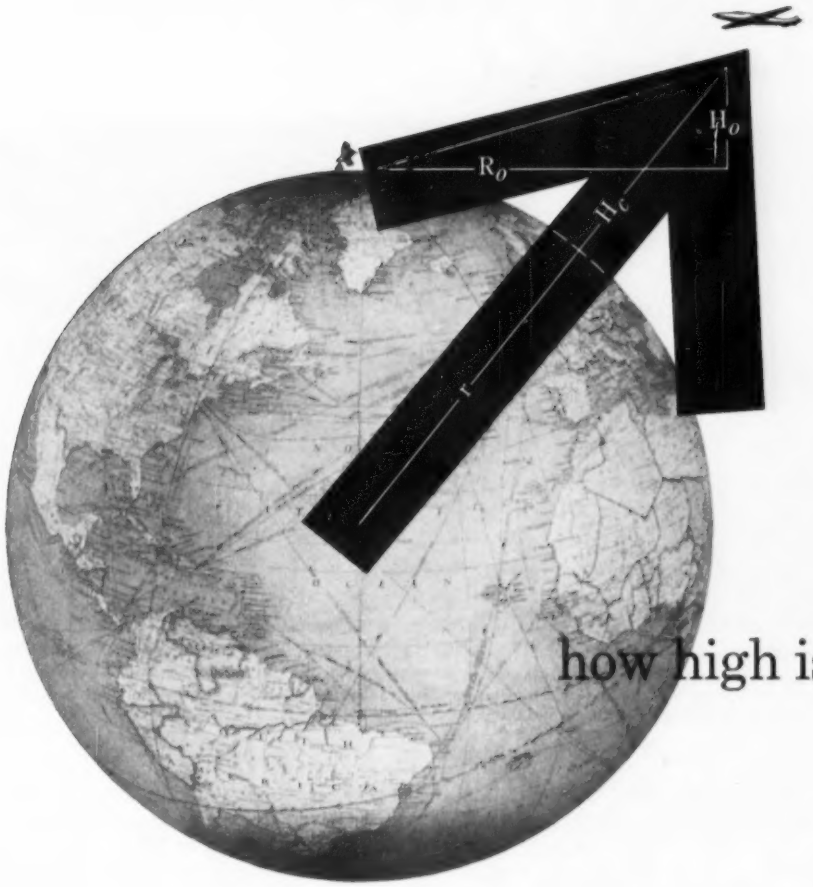
Surface weather conditions that make shipboard diving operations hazardous do not restrict the use of this device for surveillance of salvage and submarine rescue problems in advance of the diving operation.

Provision has been made for the addition of a mechanism to the unit that will be experimentally applied to aiding the salvage diver in performing his task.—G.T.M.

(continued on page 178)

Undersea camera (shown above) is small compared with the equipment designed to take it underwater and control its position. The television pickup device is contained in the cylindrical housing at the bottom, with illuminating lamps on each side. A piston used in pointing the camera can be seen near the technician's hand, almost in front of his face, while above, gears used to swivel the camera are visible. Three fan-like propellers are mounted near the upper rim of the framework. The unit can be maneuvered about or caused to hover when they are made to rotate.

Control console for the undersea television camera is shown at the right. Two monitor oscilloscope screens indicate to the operator what the camera sees. Other meters and indicators show the length of cable out, its tension, depth and number of hours service on the illuminating lamps.



how high is up?

A child's conundrum becomes a matter of life and death... when radar tells a lie. When our radar tracks attacking aircraft... or an incoming missile... the lives of all of us on target balance on the pinpoint of a mathematical riddle.

How high is up? It depends on the point-of-viewing.

Because of earth's curvature, radar sees an interloper... 100 miles away... 6600 feet lower than it really is. Readings must be corrected instantaneously before being fed to our interceptors... otherwise, attacker and defender play true or false at twice the speed of sound.

Electronic Engineering Company of California has designed an analog computer that makes this vital correction... converting radar observation into true altitude above sea level. The computer continuously solves the equation

$$H_c = H_o + (R_o^2/2r)$$

The mathematics are complex. The mechanism, with a two-gang HELIPOT* series A precision potentiometer at its heart, is beautifully simple. Both are fully described in a new application data sheet... write for Data File 901.

Helipot makes precision potentiometers... linear and non-linear... in the widest choice of sizes, mounting styles and resistances. Many models are stocked for immediate shipment... our engineers will gladly adapt standard models to your requirements... or design entirely new HELIPOT *precision potentiometers for you.*

Helipot *first in precision potentiometers*

Helipot Corporation/South Pasadena, California
Engineering representatives in principal cities
a division of BECKMAN INSTRUMENTS, INC.

405 *REG. U.S. PAT. OFF.

Weather Mapping Radar Uses C-Band

Tilt control (left) operated from pilot's position can be used to change the horizontal area scanned by the antenna shown in the opposite photograph. Oscilloscope is at the center of the instrument panel. Weather radar being installed in United Air Lines

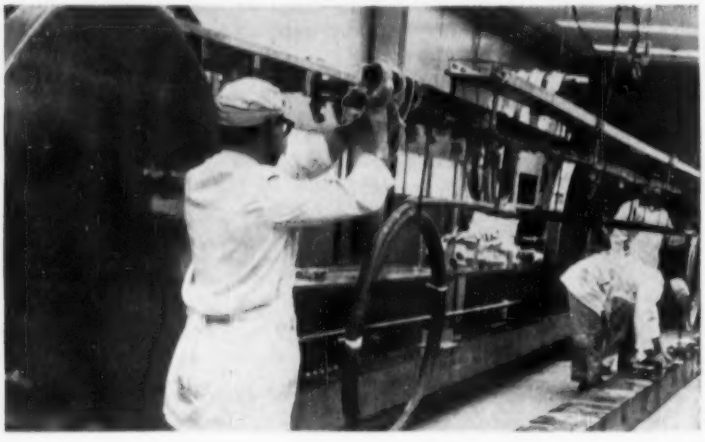
fleet uses the C-band, centered at 5.5 cm. Antenna (right) normally housed in plastic nose of aircraft is capable of 360-degree rotation but generally scans only the 240 degrees at front and sides of the aircraft nose.

TURBULENCE in the atmosphere caused by thunderstorm activity is often a hazard and always a discomfort in airline operations. Fortunately the nature of thunderstorm turbulence provides an excellent radar target. Experiments by United Air Lines, Inc. using 5.5-cm radar equipment built by RCA showed that this frequency was generally superior to either 3 or 10 cm for penetrating intervening rainfall.

Other features built into the resulting AVQ-10 weather radar, which weighs only 125 pounds, include an isoecho circuit (ELECTRONICS, p 200, Oct. 1954). The purpose of this circuit is to accentuate to the pilot the areas of densest rainfall that is associated with maximum turbulence. Since the dynamic range of the conventional ppi radar display is limited, greater effective visual range has been obtained by reversing the display where return signals are strongest.

The isoecho circuit comprises a pair of video amplifiers whose outputs are 180 degrees out of phase. When return signal intensity reaches a preset level, the out-of-phase amplifier begins to cancel the output from the other video amplifier. As a result, the display changes from a luminous area to a luminous ring. The dark center in the ring represents the area of greatest turbulence.

Transoceanic Telephone Cable Has Built-In Repeaters



BY THE MIDDLE of July, *HMTS Monarch* had already completed laying some 200 miles of submarine cable from Clarenville, Newfoundland towards the eventual eastern termination at Oban, Scotland. When the 1,900-nautical mile distance has been bridged twice by separate cables containing 52 one-way repeaters, North America and

Repeaters built at laboratory-like Western Electric plant are carefully packaged for shipping to cable company for incorporation in cable and armoring. Later they will go under the ocean where they are expected to function satisfactorily for 20 years.

THIS IS IT

NEW 3-WATT Blue Jacket®

miniaturized axial-lead wire wound resistor

This power-type wire wound axial-lead Blue Jacket is hardly larger than a match head *but it performs like a giant!* It's a rugged vitreous-enamel coated job—and like the entire Blue Jacket family, it is built to withstand severest humidity performance requirements.

Blue Jackets are ideal for dip-soldered sub-assemblies . . . for point-to-point wiring . . . for terminal board mounting and processed wiring boards. They're low in cost, eliminate extra hardware, save time and labor in mounting!

Axial-lead Blue Jackets in 3, 5 and 10 watt ratings are available without delay in any quantity you require. ★ ★ ★

SPRAGUE TYPE NO.	WATTAGE RATING	DIMENSIONS L (inches)	D	MAXIMUM RESISTANCE
131E	3	1⅜	¾	10,000 Ω
27E	5	1¾	⅝	30,000 Ω
28E	10	1¾	⅝	50,000 Ω

Standard Resistance Tolerance: ±5%

SPRAGUE

WRITE FOR ENGINEERING BULLETIN NO. 111B

SPRAGUE ELECTRIC COMPANY • 35 MARSHALL ST. • NORTH ADAMS, MASS.

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PRIN-CIR
CONNECTORS

revolutionary
NEW
contact design

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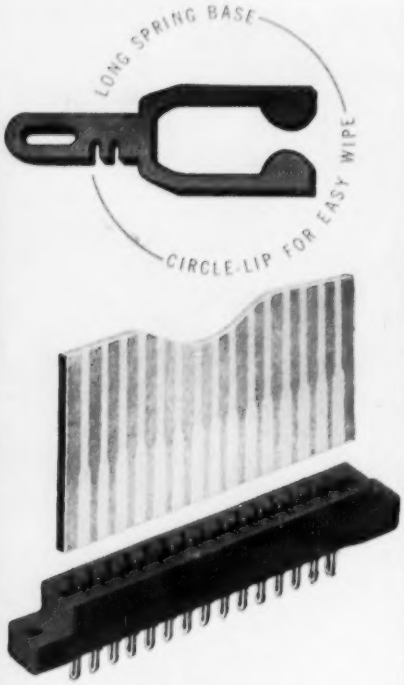
4 contact tail styles · · ·



10, 15, 18, 22 contacts · · ·

Prin-Cir connectors are the result of careful design work by AMPHENOL Development Engineering. They feature compact bodies and a new contact design that is greatly superior to any available for printed circuit applications.

Prin-Cir contacts can't be set, can't be overstressed when used with standard .061" to .071" boards, have very low millivolt drop and extremely long life. This contact has an extra-long spring base and a circle-lip for good wiping action.

Prin-Cir connectors are available with 10, 15, 18 and 22 contacts in four contact tail styles: Standard Eyelet, Wire Wrap, Pin and Open End. They may be ordered with one or more polarizing keys in any contact location.

Bodies are molded of an improved version of AMPHENOL blue dielectric and contacts are gold-plated.

Write for special Product Bulletin!

AMERICAN PHENOLIC CORPORATION
chicago 50, illinois

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AMPHENOL CANADA LIMITED, *Toronto*

AMPHENOL

the British Isles will be linked for the first time for wire telephone service.

Plans call for opening 36 circuits late in 1956, thus greatly increasing reliability of telephone service which since 1927 has been carried on by radiotelephone. The $40,000,000 project is a joint undertaking of American Telephone and Telegraph Co., British Post Office and Canadian Overseas Telecommunication Corp.

Also involved is Eastern Telephone and Telegraph Co., a Canadian subsidiary of AT&T, which will operate the Dominion section of the microwave radio relay system connecting Portland, Maine and Sydney Mines, Nova Scotia. The Nova Scotia-Newfoundland cable using 16 repeaters of British design will operate in either direction.

The deep-sea repeaters, which will be spaced about 40 miles apart, employ 3 electron tubes and are each housed in a flexible copper tube some 8 feet long and 1¾ inches in diameter. Supported on the inside by steel rings, the repeater subassembly is finally built into the cable and appears only to be a tapering bulge. It can thus pass through the cable ship's gear so that laying will be uninterrupted.

Higher Velocity of Propagation

CONSISTENTLY higher values than 299,776 ± 4 km per sec for the velocity of propagation of electromagnetic waves have been reported since the war. A new average value recently announced is 299,793 ± 1 km per sec.

Results obtained by the National Bureau of Standards give 299,792 ± 6 km per sec by the molecular constants method and 299,795 ± 3.1 km per sec by the radio interferometer. The final value for velocity of propagation for radio waves in free space was determined as a weighted average of 110 independent measurements made during 10 days. The uncertainty of ±3.1 km per sec includes an estimated systematic error of ±0.7 km per sec in addition to a 95-percent confidence

PERFORMANCE-GUARANTEED

Magnetic Shields

COST NO MORE-

WHY TAKE LESS?

You're time and money ahead with Performance-Guaranteed Magnetic Shields, for our shields are *guaranteed* to meet the requirements of your circuit to mutually agreed upon shielding specifications. Dry hydrogen annealed, as required . . . of MuMetal, A.E.M. 4750, or whatever commercially available material is most suitable . . . fabricated or drawn . . . painted or lacquered to match any shade, or unfinished. Write for the industry's most complete catalog, MS-104, today.

MAGNETICS inc.

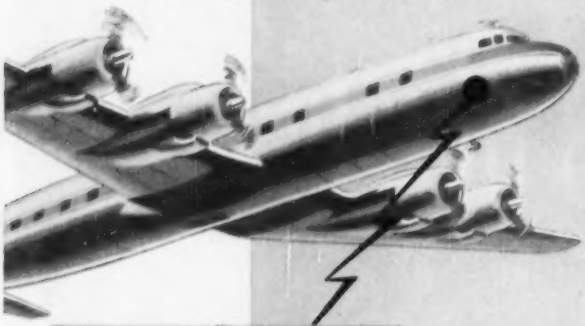
DEPT. E-26, BUTLER, PA.

PERKIN

AIRBORNE RADAR

DC POWER SUPPLIES

for Military and Commercial Aircraft



TYPICAL** 6000 VOLT MODEL
DC OUTPUT: 6KV ±5% @ 100 microamperes

ELIMINATES LEAKAGE PROBLEMS AT HIGH ALTITUDES INHERENT IN OIL-FILLED DESIGNS—HERMETICALLY SEALED AND POTTED WITH A SPECIALLY FORMULATED EPOXY RESIN.*

SPECIFICATIONS:

1. D. C. OUTPUT VOLTAGE TAP provided at 600 V.
2. A. C. INPUT: 100-120 Volts, 380-420 cps, Single Phase
3. RIPPLE VOLTAGE: Less than 120 Volts, peak to peak
4. TEMPERATURE RANGE: —55°C to +85°C ● 50,000 feet altitude

COMPONENTS: NO TUBES! Conservatively designed and derated selenium rectifier cartridges connected in voltage quadrupler circuit.

DIMENSIONS: 2" High x 5¼" Long x 4" Wide

WEIGHT: 2¼ lbs.

Perkin Engineering Corp. has been designing and manufacturing AIRBORNE HIGH VOLTAGE RADAR POWER SUPPLIES since 1951. There are over 3,000 Perkin units operating in Military and Commercial Radar Systems (such as APS - 42 etc.) with no reported cases of field failures whatsoever.

*Perkin units do not employ standard commercial catalog resins. Special epoxy resins are formulated for each unit (depending on the voltage and temperature ratings) by our chemists.

**8 KV, 10 KV and other ratings can be designed for your specific mechanical and space configuration.

PLEASE SEND US YOUR SPECIFICATIONS FOR OUR PROMPT ANALYSIS and QUOTATIONS or
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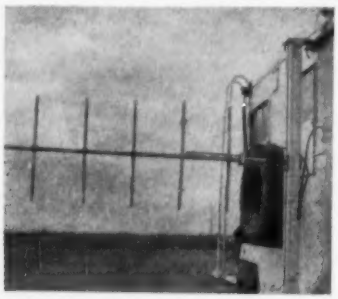
PERKIN D C power supplies

interval for the mean value of the measurements.

Two receiving antennas spaced 1,500 meters apart were used. By varying the position of a transmitter over a path that halfway encircled the two receiving antennas, the phase difference between the receivers was made to change. Wavelength of the radio waves was then calculated by dividing the accurately known distance between the receiving antennas by half the total change in phase difference.



Five-element antenna used at one of the transmitting stations. Measurements were carried out on a dry lake bed near Willcox, Ariz. where a five-mile bare flat surface was available

A radio frequency of 172.8 mc obviated skywave interference and minimized ground effects. In practice, two transmitters were located on extensions of the line through the two receiving points. Change in phase difference was then noted at the receiving points when the transmission was switched from one transmitter to the other. Ambiguity was resolved by moving one transmitter across exactly one half the equiphase contours between the two transmitter positions. For convenience, the actual measurement was made at audio frequency by heterodyning to 1 kc. Frequencies of the transmitters and the resulting heterodyne were checked against WWV. Accurately known ground constants were used to adjust for ground effects while the index of refraction of the air was calculated as a function of temperature, pressure and humidity.

Radar Aids Meteorology

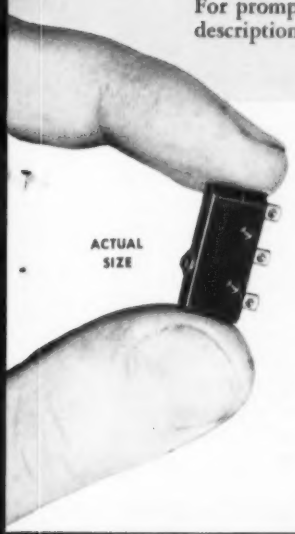
RADAR techniques used for tracking isolated showers and thunder-

Electro-Snap Switches Can Be Adapted to Almost Any Job — Quickly, Easily, Economically

Just choose the Electro-Snap Basic Switch that meets your electrical requirements, add the proper actuator — and presto! — you have a tailor-made precision switch that exactly fits your application. Electro-Snap makes a wide variety of stock actuators to fit almost any requirement. And our engineering department is at your service if a standard combination "won't fill the bill."

For prompt action on your switching problems, send us a brief description and rough sketch of the switch you need.

Switching Problem?



SUB-MINIATURE SWITCHES TYPE E-4

S.P.D.T., 1 circuit; 5 amps, 125/250 v. AC Operating force 150 grams max. Exceptionally vibration-resistant. Special model E4-7 is stabilized for — 65° to + 350° F. operation.

Push Button Actuator

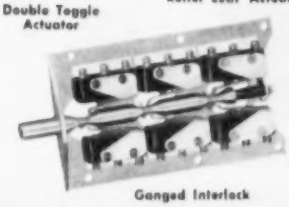
Toggle Actuator (Momentary or Constant Contact)

Double Toggle Actuator

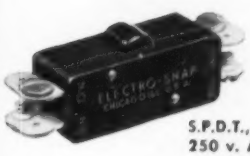
Roller Leaf Actuator

Leaf Actuator

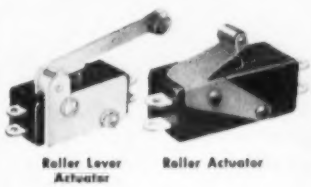
Extension Leaf Actuator

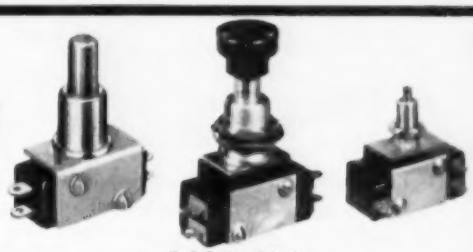

Ganged Interlock

TYPE S SWITCHES Series S1



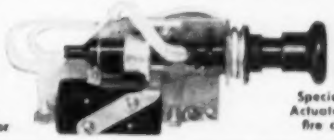
S.P.D.T., 2 circuit; 10 amps, 125/250 v. AC/ 30 v. DC. Ind. Screw or solder terminals on ends or one side of switch. Also available with reset button at bottom of switch or in Type S-100 Make-Before-Break Series where switch completes a new circuit before interrupting old one.

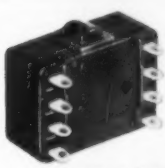

Roller Lever Actuator — Roller Actuator


Push Button Actuators (Various button sizes available)

Toggle Actuator (momentary or constant contact)

Extension Leaf Actuator


Special Push Button Actuator designed for fire control system



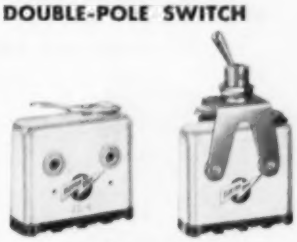
DOUBLE-POLE SIMULTANEOUS ACTION TYPE D-8

D.P.D.T., 4 Circuit
15 amps, 125/250 v. AC.
10 amps, 30 v. DC Ind.
Eight terminals and four separate circuits which operate simultaneously permit switch to reverse 3-phase motors, replace expensive relays, etc.

Roller Leaf Actuator — Roller Lever Actuator — Leaf Actuator

Extension Leaf Actuator — Push Button Actuators (Various button sizes available)

HERMETICALLY-SEALED DOUBLE-POLE SWITCH


Type J2-4 — Toggle Actuator for J2-4

D.P.D.T., 4 circuit 10 amps, 125/250 v. AC/30 v. DC.

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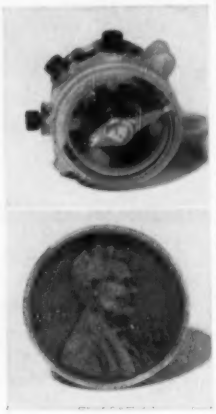
HOW 3-D MICRO-VISION HELPS FAIRCHILD

manufacture world's tiniest production-run potentiometer



In a case less than ½" in diameter, 35 sub-miniature parts are precision-assembled; hair-thin springs are welded into fine slots. This tiny unit, designed and developed by the Guided Missiles Division of Hughes Aircraft Company, is a sensing and controlling element for aircraft and missiles; critical tests must assure highest mechanical and electrical efficiency.

Fairchild Camera and Instrument Corporation attributes the efficient mass-production of this unit to the use of Bausch & Lomb Stereomicroscopes—in assembly, inspection, and quality control. "Operators have both hands free and use both eyes to obtain normal, three-dimensional vision magnified to the required power—with high efficiency and operator comfort."

Write for FREE Copy of this Exclusive 3-D Micro-Vision Data Book

- See actual stereo views!
- Know *how* and *where* to use Stereomicroscopes!
- Fit exact model to job needs with Selector-Chart!

WRITE TODAY for Data Book D-15. Bausch & Lomb Optical Co., 61445 St. Paul St., Rochester 2, N.Y.

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SINCE 1853

America's only complete optical source . . . from glass to finished product.

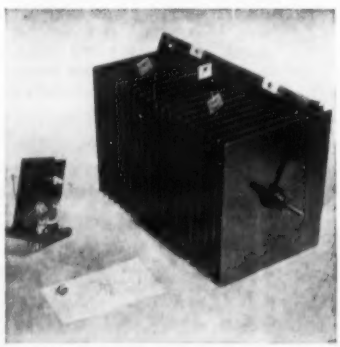
storms have been known and employed for some time. A greater field of usefulness for radar lies in the study of cloud physics, according to Alan C. Bemis, of Massachusetts Institute of Technology. The term cloud physics includes the study of all physical processes occurring within clouds.

The theory for formation of rain based upon ice crystals has been supplanted to a great extent as a result of radar and aircraft explorations. It was formerly generally believed that the introduction of a few ice crystals among many supercooled cloud drops caused ice crystals to grow at the expense of the water drops. With increase in size, they were thought to fall out as snow, melting to rain at lower altitudes. These studies continue.

In a paper describing work carried out under a Signal Corps contract, Bemis showed the relation between radar signal intensity and the number and size of droplets causing the echo.

Radar echoes from precipitation are returned by the drops within a volume of space determined by the beam width and half the pulse length. The intensity of any single returning pulse is a function of the spatial distribution of the drops

Silicon Power Rectifier



The 20-finned selenium rectifier at the right is typical of those used in the telephone plant for converting alternating to direct current. Bell Labs' new silicon power rectifier at the left comprising four units and two cooling fins may eventually replace the larger one. Active elements are 4 wafers a tenth of an inch square, similar to those on the paper in the foreground. A wafer is placed in a tiny can and attached to a bolt for mounting

BJ
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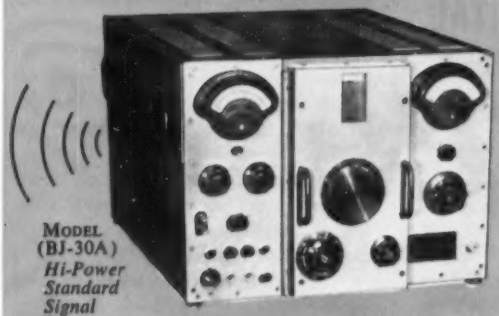

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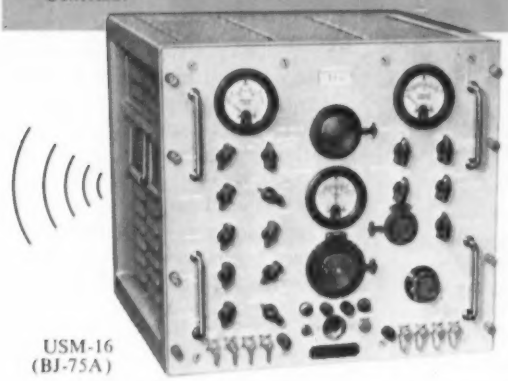

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DETAILED SPECIFICATIONS

Model	902AJ	902BJ	902BK	902CJ	902CK
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Tape Width (inches)	¼	½	½	⅝	⅝
Tape Speed (in./sec.)	15/30	15/30	15/60	15/30	15/60
Reel Size (dia. in inches)	10½	10½	8	10½	8
Reel Capacity (feet)	2,400	2,400	1,200	2,400	1,200
Start Time	5 Milliseconds				
Stop Time	5 Milliseconds				

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and this changes from pulse to pulse causing a grassy appearance on an R-scope. It has been found impossible to compare accurately the height of the grassy echo with the pip from a signal generator.

Fortunately, the average value of the signal intensity is a function of ΣNd^6, that is, the number and size of the drops causing the echo. It is relatively simple to build an electronic device that remembers the size of each returning pulse and averages it with its immediate successors. Output from such a meter can record continuously the average value of about 1,000 pulses. Theory and experiment agree that 1,000 at usual repetition rates gives a good average.

Measurement of average signal intensity does not, however, uniquely determine the number and size of the raindrops being examined, but knowledge of characteristic drop size distributions and other measurements permit the cloud physicist to deduce much from radar signal intensity data.

For example, it can be assumed under some conditions that the number of particles N remains constant with time. Then the changes of ΣNd^6 measure changes of particle size. Much time has been spent on the average or most common relationship between ΣNd^6 and precipitation rate, so that a single radar may be used as a rain gage covering thousands of square miles. The results show useful accuracy for certain applications in hydrology, agriculture and flood control.

Rain Gages Send Radio Reports

McG-H Pacific Coast News Bureau

Flood conditions in the Sacramento River drainage basin are subject to extensive control by regulation of water released from Shasta and Keswick Dams. Such control is based upon runoff information.

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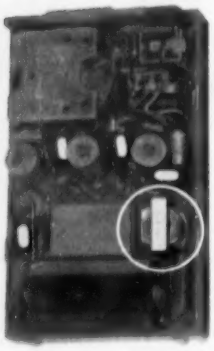

Rear view of pocket radio with back removed, showing TI transformer and transistors in relation to other circuit components.

TWENTY-FIFTH YEAR OF PLANNED GROWTH

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formation on flood-producing rainfall. Terminating at the Bass Mountain relay station, these radio circuits are controlled from the nearby Keswick Power Plant. Location of the stations and distances involved are indicated from the map in Fig. 1.

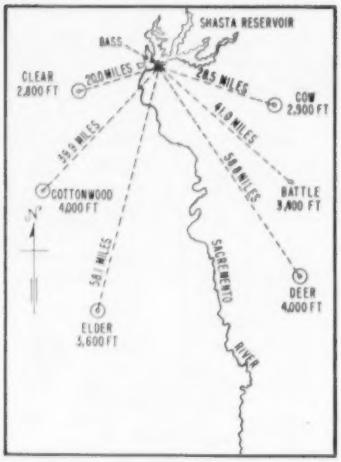

FIG. 1—Map shows orientation of reporting stations that are located on or adjacent to streams that contribute to flood conditions

A new type of heated precipitation gage shown in Fig. 2 and 3 weighs snow or rain, producing distinctive signals by means of a photoelectric coding apparatus.

FIG. 2—General view of Deer Creek reporting rain gage station

The operator at the control point (Fig. 4) selects the station to be checked, presses a key to call it and reads from an oscilloscope the reply

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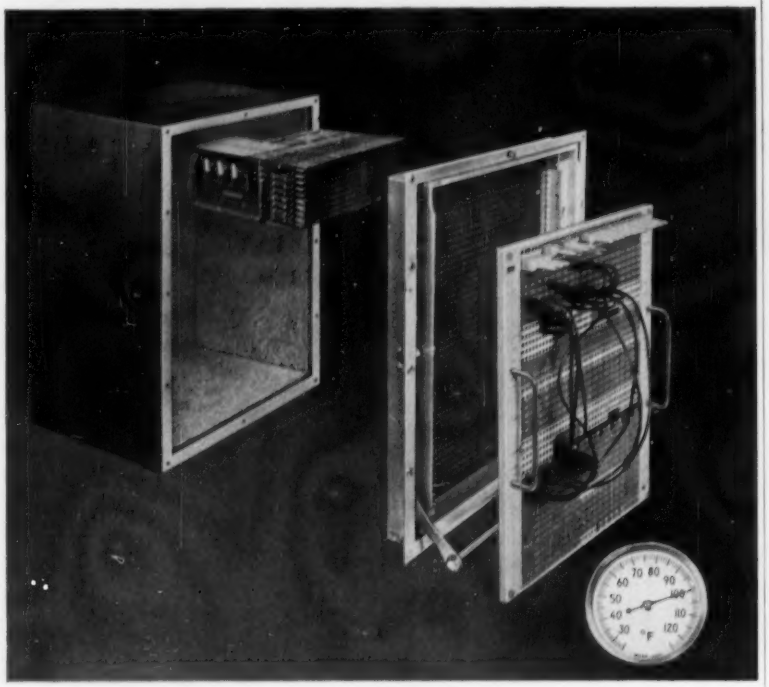
News in Analog Computing...



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indication of precipitation caught. This information is then transmitted by teletypewriter circuit to water control headquarters.

With the system, flood peaks can

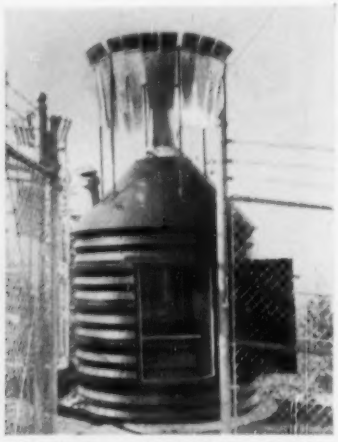


FIG. 3—Deer Creek radio reporting rain gage station showing special baffle around mouth of gage opening to cut down wind eddies and insure representative catch

FIG. 4—Operator interrogates rain gage station and receives coded report on a cathode-ray oscilloscope

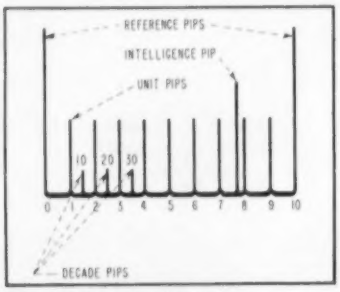
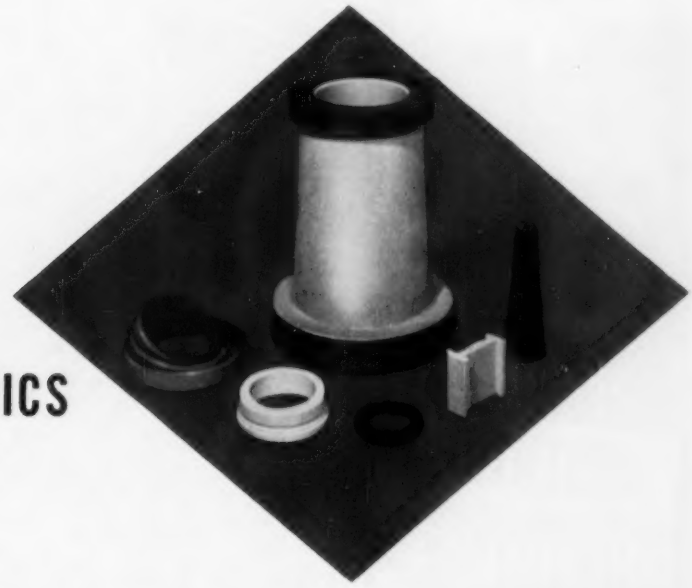


FIG. 5—Example of coded report shows 37.75 inch rainfall



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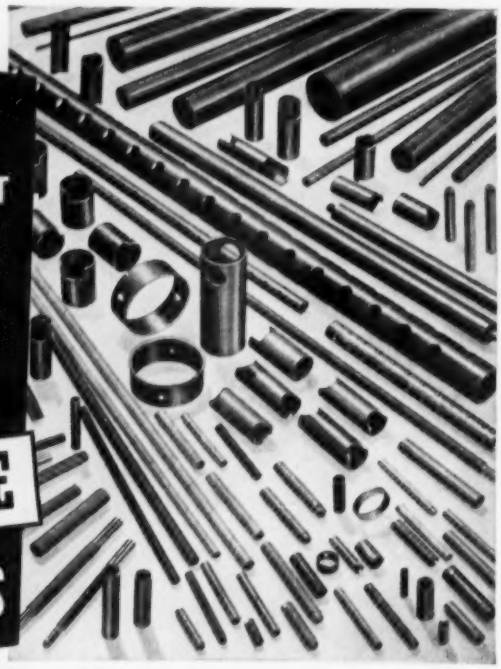

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Square-Law Circuit

By K. S. Lion
and R. H. Davis
Department of Biology
Massachusetts Institute of Technology
Cambridge, Mass.

Elements having a square-law characteristic are frequently used in analog computers, in particular for multiplication problems. Four types of such elements are primarily employed.

Thermal instruments are used, such as thermoconverters[1] or temperature limited diodes[2], having an output voltage proportional to the temperature of a wire, which in turn is proportional to the square of an input voltage or current. The time constant of such devices is high, sometimes up to several seconds.

Parabolic functions can be synthesized from segments of diode characteristics.[3] Such setups require a considerable number of elements; for instance Chance[4] uses 15 diodes for a range from 0 to 25 volts input, while Marshall[5] uses 22 diodes for a range of −100 to +100 volts input.

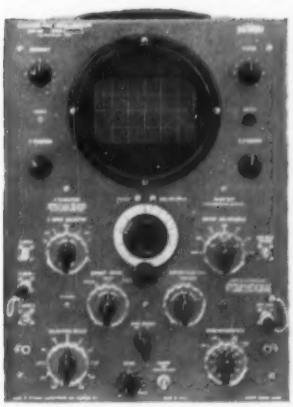
Beam deflection square-law tubes[6] can be used, in which an electron beam of rectangular cross-section strikes a parabolically shaped target. The input voltage deflects the beam and the amount of target current varies in accordance with the shape of the target. This method requires special tubes[7].

For applications where moderate accuracy is satisfactory, triodes or pentodes can be employed and operated in the limited range where the plate current varies approximately with the square of the grid voltage or screen voltage[8]. The characteristic of such tubes changes with age and operating conditions.

New Circuit

The new square-law device described in this paper and illustrated in Fig. 1A requires a source furnishing a triangular wave of negative polarity e_r. It is connected in series with the input signal e_i and applied to a diode D and a load re-

IBM selects DU MONT TYPE 329* as test oscillograph for their new type 702 computer



When IBM Corporation, world's largest manufacturer of computer equipment, produced their new Model 702, an essential phase of the project involved selection of a cathode-ray oscillograph to go into the field with each computer as standard test equipment. Requirements were strict.

IBM's approach to the problem was to conduct side-by-side evaluation with other competitive instruments. On the basis of actual performance, they selected the Du Mont Type 329 as their test oscillograph.

What are some of the primary reasons why IBM decided on the Du Mont Type 329? Excellent sensitivity—either d.c. or a.c. coupled. Precisely calibrated sweeps with movable notch magnification—ideal for making accurate measurements. Brightness—adequate for display of very fast pulses. Synchronization simplicity—the Type 329 "locks in" on almost any type of signal. Stability—the trace remains steady as a rock despite power line fluctuations, etc. Reliability in service—calibration adjustment requires no extra test gear and is a simple one-step process. And virtually any tube may be replaced without special selection.

Another factor contributing to the selection of the Type 329 was the well known Du Mont Field Service Organization, which assures that regardless of where in the United States the equipment is used, swift, competent service facilities are in the immediate vicinity.

If you have instrumentation requirements, Du Mont facilities are always available for discussion and recommendations. Write us today for complete information on the Type 329, or on any problem you may have relating to cathode-ray instrumentation.

*"Modified slightly for IBM's application."

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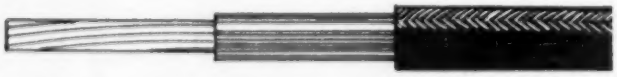

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sistance R_o. A saw-tooth source can be used instead of the triangular-wave source, the only requirement being that the sides of the triangles are straight.

As long as the signal voltage e_i is zero, the plate potential of the diode alternates between zero and the negative peak value of the triangular wave; therefore no current passes the diode and the voltage e_o across the resistor R_o is zero. If an input signal e_i is applied with a positive polarity (as indicated in Fig. 1) the plate potential of the diode becomes positive for a fraction of the triangular cycle; a current passes the diode so that triangular voltage pulses e_o (area a) appear across the resistor R_o.

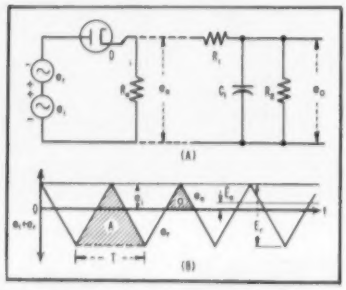

FIG. 1—Circuit (A) and mode of operation (B) of basic square-law circuit

From a simple geometric considerations the areas of the triangles a are proportional to the square of their altitudes. They are proportional to the square of the signal voltage e_i. Since the areas of the triangles a are also proportional to their average value $\overline{E}_o$ an average-forming network consisting of R_1, C_1 and R_2 furnishes the desired result.

Voltage e_o at the output of this network is proportional to the square of the input signal e_i. The average-forming network can be omitted if the subsequent stage responds directly to the average value, for example, a moving-coil system of sufficient inertia.

In quantative terms, if a designates the area of the small triangles, A the area of the reference pulse and E_r the peak value of the triangular source voltage, then

$$\frac{a}{A} = \frac{e_i^2}{E_r^2}, \quad a = \frac{A}{E_r^2} e_i^2$$

The average voltage for each small

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The RD1 is a SPST relay, available with either normally open or normally closed contacts. A similar relay (Type RE2) has SPDT contacts and slightly larger models (Type RM2 and RM4) are made with 2PDT and 4PDT contact arrangements. These units have peak working voltage ratings up to 12,000 volts and continuous RF current ratings of 10 amperes rms at frequencies up to 30 mc. It is also possible to make and break under load with fast break times of less than 10 milliseconds. Switch capacitances are as low as 0.1 mmfd and contact resistances are as low as .005 ohms. As their contacts are sealed in a vacuum, contact resistance does not increase with usage. This factor makes them excellent general purpose relays for DC switching.

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Typical specifications are shown above. Modifications of total delay, tap delay, rise time, attenuation, impedance, bandwidth, dimensions, and mounting are readily possible to match individual requirements exactly.

For detailed specifications and dimensions of basic types, send for Bulletin L-38. A copy of Specification Sheet SS-7 will also be enclosed so you may fully outline your delay line requirements for a prompt recommendation by Shallcross Engineers.

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pulse with the area a is

$$\overline{E_a} = \frac{a}{T} = \frac{A}{T E_r^2} e_i^2$$

or, since $A = \frac{1}{2} E_r T$, the average voltage is

$$\overline{E_a} = \frac{1}{2E_r} e_i^2 = \text{const} \times e_i^2$$

This voltage is independent of the frequency and the shape of the reference voltage.

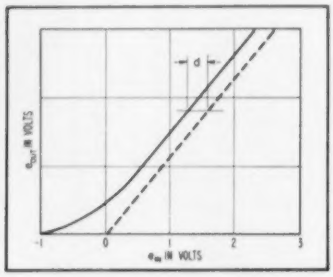

FIG. 2—Ideal switch (dashed line) contrasted with diode characteristic (solid line)

The voltage e_a is applied to the averaging network R_1, C_1, R_2, which must satisfy the equations $2\pi f_r R_1 C_1 >> 1$ and $2\pi f_i R_2 C_1 << 1$, where f_r is the frequency of the triangular wave-form generator and f_i the sinusoidal frequency of the input signal. If then $R_1 >> R_a$, the output voltage will be

$$e_o = \frac{1}{2E_r} \frac{R_2}{R_1 + R_2} e_i^2$$

The circuit has the advantages of predictable response characteristics, zero output for zero input and no fundamental limitation on output range.

The major limitation of the device is its restricted frequency response. The ease with which two or more units with identical characteristics can be constructed permits the combination of a pair of the devices into a simple multiplier.

Errors

Errors may arise from the departure of the characteristics of the diode from those of an ideal switch and from variations in magnitude and deviation from linearity of the triangular wave form.

The characteristic of a diode is shown as a solid line in Fig. 2. It departs from that of an ideal switch (dotted line) in two ways.

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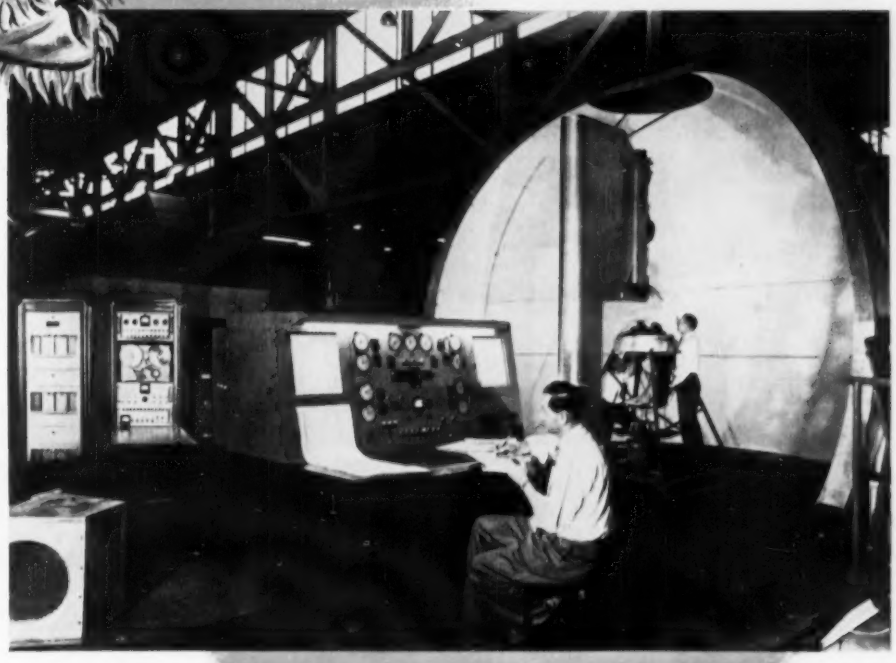

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about 1 volt, the output is proportional to the sum of the input voltage and a small voltage, d. The effect of any constant component of voltage d may be eliminated by placing a corresponding bias voltage in series with the diode. The effect of any variable component of d may be reduced by means described by Kelner, Gray, and MacNichol[9]. Any residual component of d will produce a fractional error in the output equal to d/e_i.

Output voltage is not linearly related to the input voltage for values of input voltage less than about 1 volt. This deviation from linearity may be minimized by using a load resistance R large compared with the diode resistance.

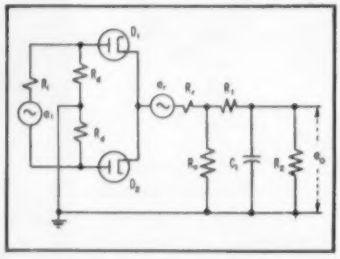

FIG. 3—Square-law circuit for both positive and negative inputs

The cathode-to-plate capacitance of the diode results in current approximately equal to $R_s\ C_d\ de_r/dt$ where C_d is the capacitance of the diode. If a symmetrical triangular wave form is used for e_r, the output will be a square wave of an average value equal to zero, so that no error results. If e_r is not symmetrical in form, the effect may still be canceled by subtracting from the output an equal and opposite voltage derived from a similar circuit in which the diode is replaced by an equivalent capacitance. In either case, the error may be minimized by reducing the value of R_s, choosing a diode with low capacitance and careful wiring of the circuit.

Since the output is inversely proportional to the magnitude of the reference wave form, variations in its magnitude produce fractional errors equal to the ratio of the deviation to the standard magnitude. Errors due to departures from linearity may be computed if the shape of the reference wave form is

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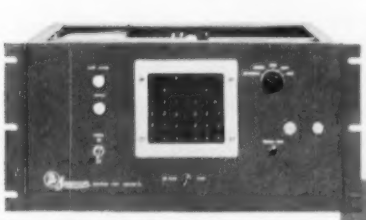

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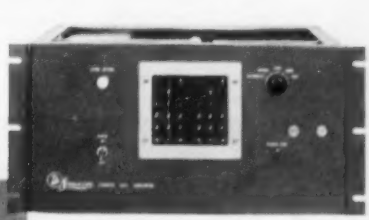

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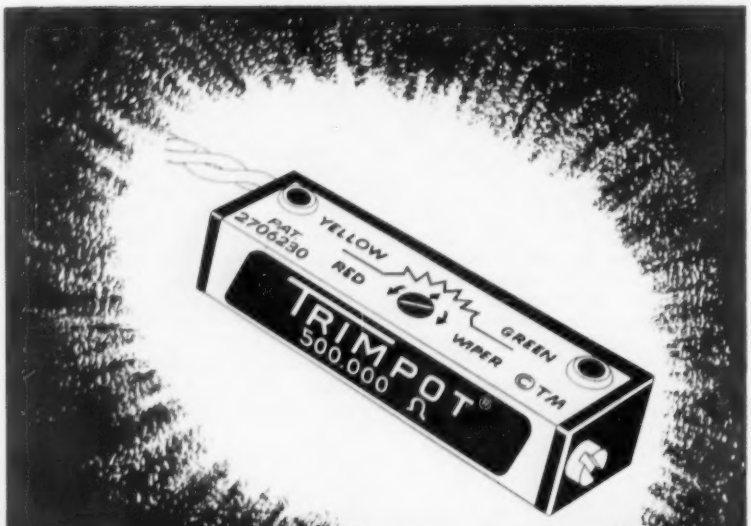

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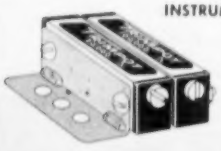

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known. For the case where the sides of the triangle are exponential in form, the maximum output error, expressed as a fraction of the full-scale output of the instrument, is approximately equal to one-fifth of the fractional change in slope.

Applications

The circuit shown in Fig. 1 has an output equal to zero for negative input signals. If the input signal e_i is available balanced to ground, a circuit operative for positive and negative values of signal voltage may be constructed as shown in Fig. 3. This circuit acts as a true square-law device. Output is equal and of the same sign for both positive and negative signals of the same magnitude.

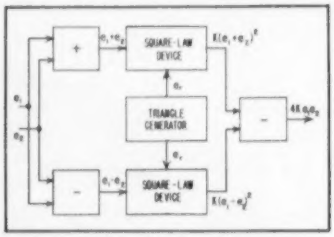

FIG. 4—Circuit to multiply e_1 and e_2

Since the output characteristics of this circuit are determined only by the magnitude of the triangular wave form, a second circuit with identical characteristics may be easily constructed with the reference wave forms for each circuit derived from the same source. A pair of devices with identical characteristics will accept both positive and negative input signals.

They may be combined, therefore, to form a multiplier of the quarter-square type depending on the relation

$$(e_1 + e_2)^2 - (e_1 - e_2)^2 = 4e_1e_2$$

Since matching of the characteristics of the two square-law devices is automatically maintained, satisfactory operation of such a multiplier is insured. A block diagram of such a multiplier is shown in Fig. 4.

Practical Results

The operation of the square-law device shown in Fig. 3 has been tested both qualitatively and quantitatively. Characteristics of the square-law device for d-c input sig-

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nals was found to be accurate within the limits of accuracy set by available measuring instruments, about 0.2 percent of full scale for a range of input signals between 10 and 50 volts.

Response of the device for a-c signals was tested in a qualitative manner by observing the output of the device with a cathode-ray oscilloscope. Using for e_r a triangular wave of 1,200 cps, the frequency of the input signal could be raised to about 135 cps without noticeable distortion of the output.

The research described was supported by a grant from the Office of Naval Research, Contract NR-11 705.

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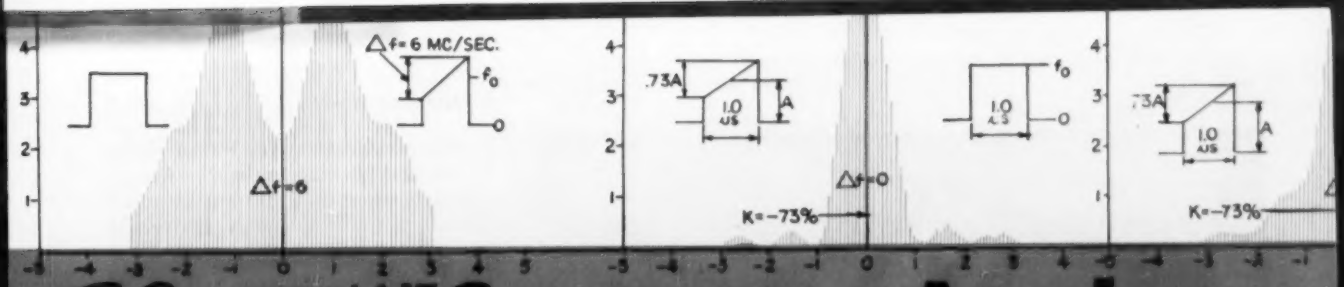
Aeronautical Communications Recommendation

RADIO COMMUNICATIONS for domestic aviation encompass several agencies. Air-to-ground communications are furnished by Aeronautical Radio, Inc. (Arinc), Interstate Airways Communication Stations (INSACS) and Air Route Traffic Control Center (ARTCC) radio stations. Point-to-point service is handled by CAA and the airlines.

Besides these facilities there are airport tower stations for local control.

Based on 1953 volume of air-to-ground contacts in Federal airways, it has been predicted that the number may well double in the next ten years. Point-to-point communications can increase to a projected 2.65 times the 1953 volume.

In a study for Aeronautical Radio, Inc., Arthur D. Little, Inc. has produced a two-volume report entitled "Engineering and Economic



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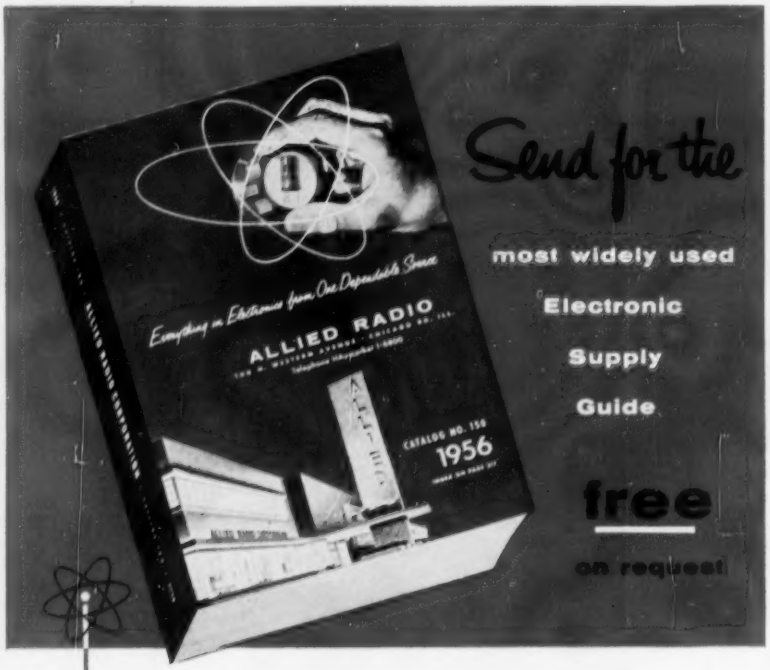

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Recommendations for Future Aeronautical Communications". Among many recommendations it is urged that the air-transport industry and CAA jointly implement an aeronautical communications system to provide, through exchanges (each one not unlike a telephone central office) all air-to-ground channels for traffic control, weather, flight information and air-carrier operational communications.

A further recommendation suggests that the air carriers and CAA explore the possibility of a microwave point-to-point communications system where economically justified, based on a rate structure that will yield $500 per system mile, to be amortized over a 10-year period.

Alternatively, these services might be procured from established common carriers.

Various new techniques can be used to advantage, including selective calling arranged to turn on a receiver for the desired communications channel. Visual displays could also be employed.

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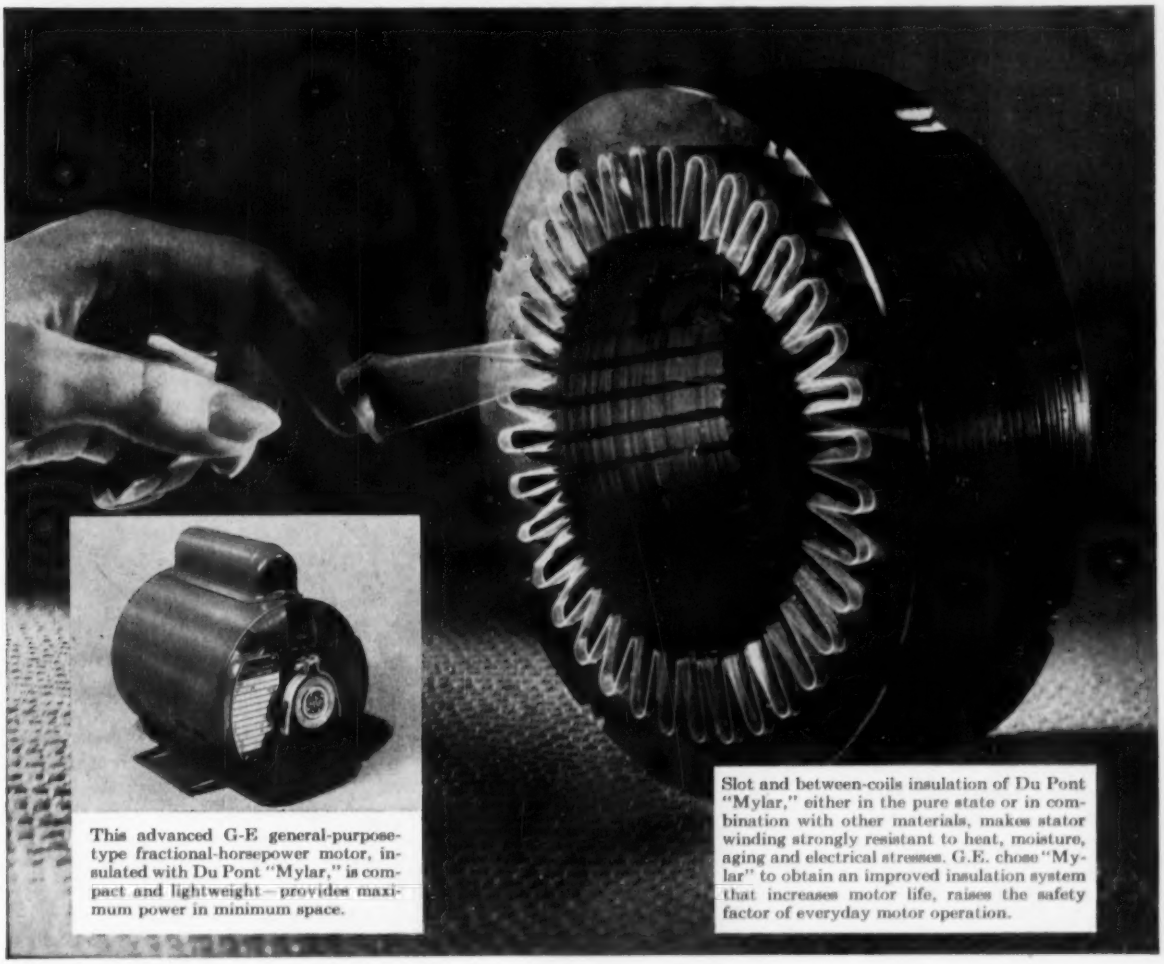

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British Color TV Tests

EXPERIMENTAL color tv transmissions were initiated during August by British Broadcasting Corporation. Emanating from Alexandra Palace, a number of different systems are being tried out with a view towards compatibility with the existing monochrome system. Program content is designed for the tests and not as entertainment. Transmissions are made after normal viewing hours. It is not expected that final decisions on the eventual system to be employed will be made before 1958.

Commercial television using black-and-white will start in Britain on September 22. Rate of expansion of commercial stations, which is subject to certain controls by the Postmaster-General, is expected to be three stations a year or less until some 20 stations may be in operation by 1964, according to information from McGraw-Hill World News.

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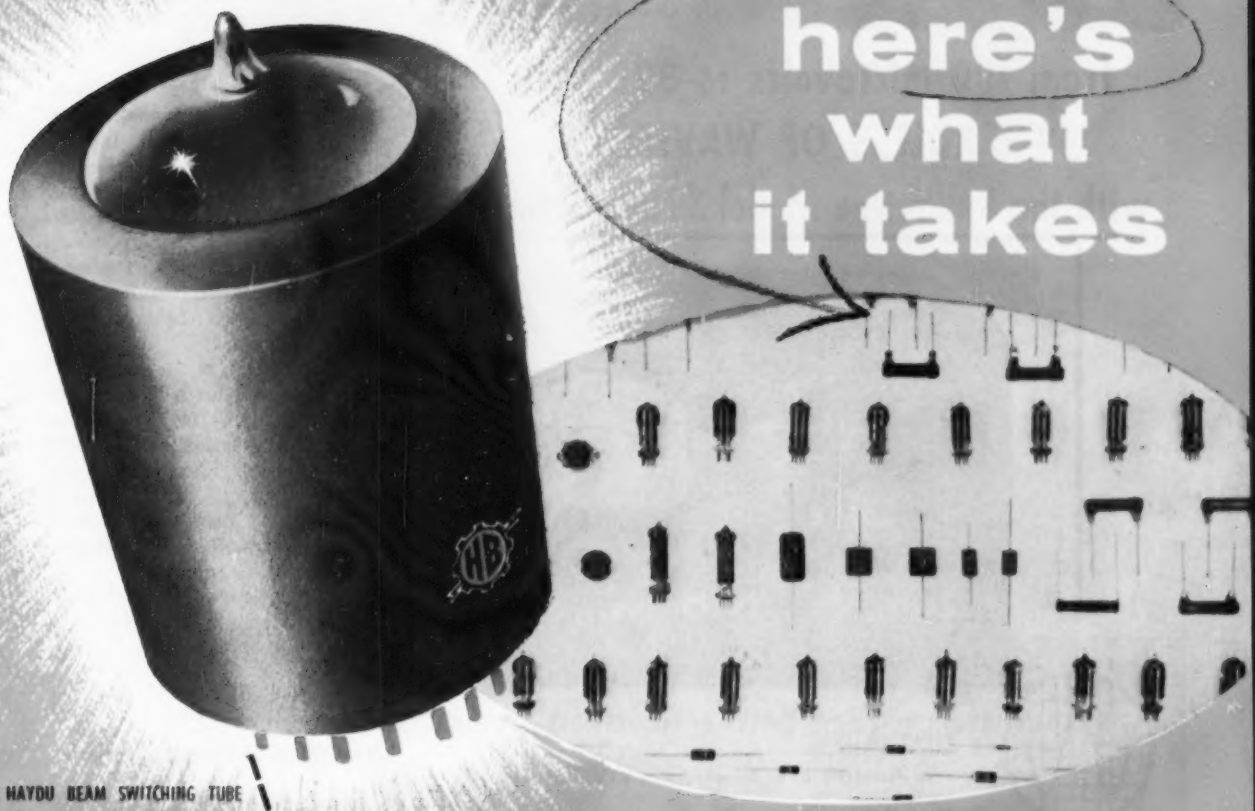

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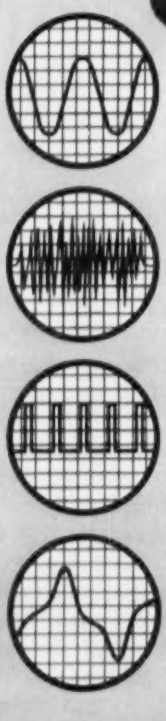

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weather in the temperate zone. This as well as means for measuring temperature and the description of a diode gating circuit are among patents chosen for review this month.

Electronic Cold

That a current of electricity passing through a metallic substance results in its being heated by the current is well-known. Likewise the fact that certain junctions of dissimilar metals generate an electric current that varies in accordance with temperature is also known. There are thermoelectric effects, apparently by which these processes are reversed.

Such an effect is the subject of patent 2,685,608 for a "Thermoelement, particularly for the Electothermic Production of Cold," awarded to E. Justi of Braunschweig, Germany. The patent is assigned to Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

This inventor explains that intermetallic compounds of certain bin-

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ary alloy systems, such as the bismuth-antimony system are known to have very high differential thermoelectric power values and high values of specific resistance.

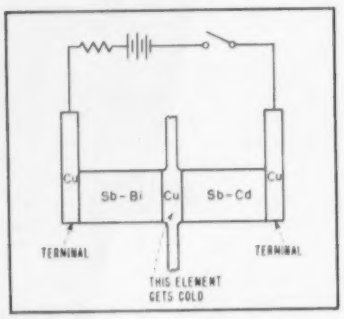

FIG. 1—Detail of thermal junction

The behavior of these compounds resembles that of semiconductors. By slightly disturbing the perfection of the binary compounds through the addition of certain impurities or departing slightly from the normal stoichiometric composition, the intermetallic compounds are converted into semiconductors with increased conduction over the perfect intermetallic compounds without showing much change in the differential thermoelectric effect.

As shown in the drawing of Fig. 1, the thermoelectric cold generator of this invention comprises a structure including a copper central element and outer elements of antimony-bismuth and antimony-cadmium intermetallic alloys respectively. The intermetallic alloys are specially prepared to have impurities to about 2 percent.

The result of the structure and circuit shown was that in passing current through the cell a temperature reduction of 27 C was effected at the central copper element.

Measuring Heat

A "Temperature Measuring Apparatus" merited patent 2,641,931 for R. F. Wild of Wilmington, Delaware, who assigned the patent to Minneapolis-Honeywell Regulator Company, of Minneapolis, Minnesota.

Usually, thermocouple voltage-measuring systems for temperature indication employ a thermocouple bridge arrangement in which by a vibrator sampling device the ther-

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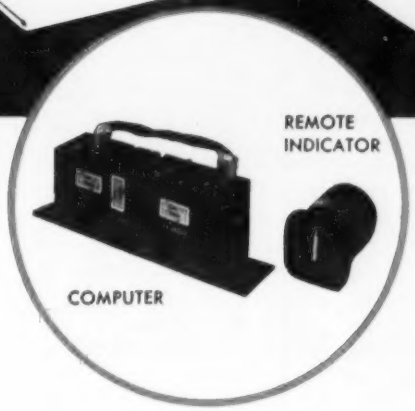

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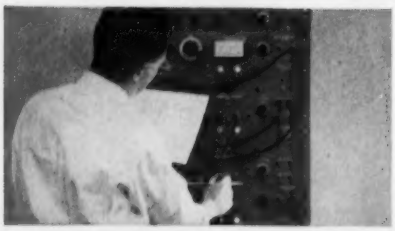

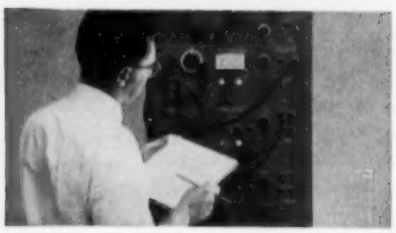

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mocouple voltage is compared with a capacitor charge. It has been found in such systems that the cold junction temperature upsets the charge conditions and impairs the accuracy of the measurement.

This inventor has inserted a capacitor of the appropriate temperature coefficient in the cold junction area of the thermocouple, which changes the balancing capacitor in such fashion as to compensate the cold junction variation.

A circuit diagram of a complete temperature measuring system is shown in Fig. 2. Capacitor C_s is the compensating capacitor. It is in parallel with variable capacitor C_v, which is controlled by a motor. The motor is controlled by the potential across capacitor C when the circuit is unbalanced.

Vibrator D alternately applies the voltage from the thermocouple to charge and discharge capacitor C_1 across capacitor C. Vibrator E performs a similar function in charg-

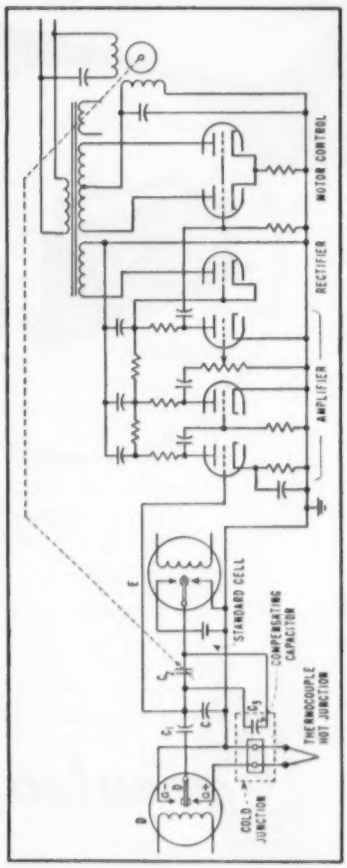
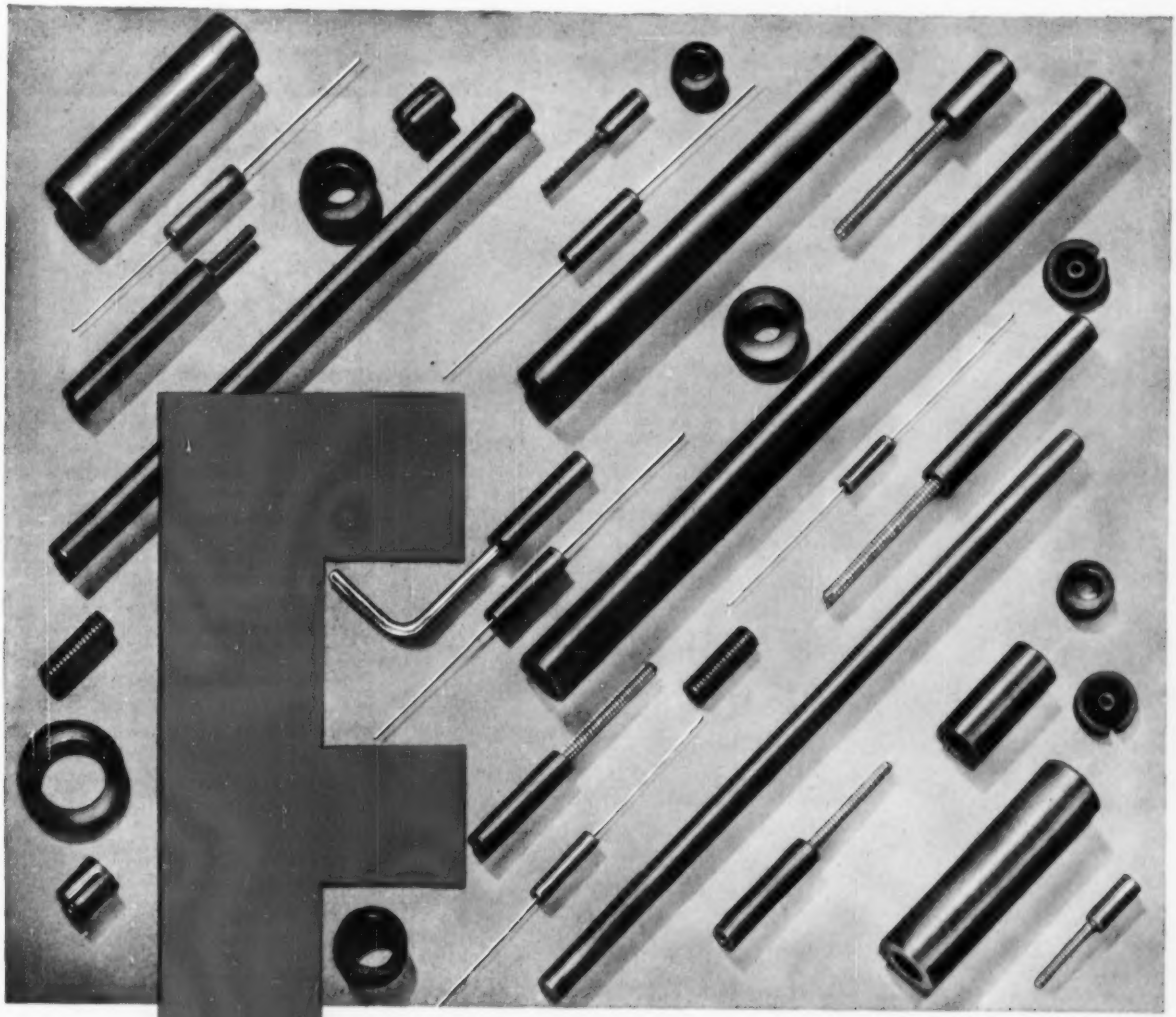


FIG. 2—Complete temperature measuring system



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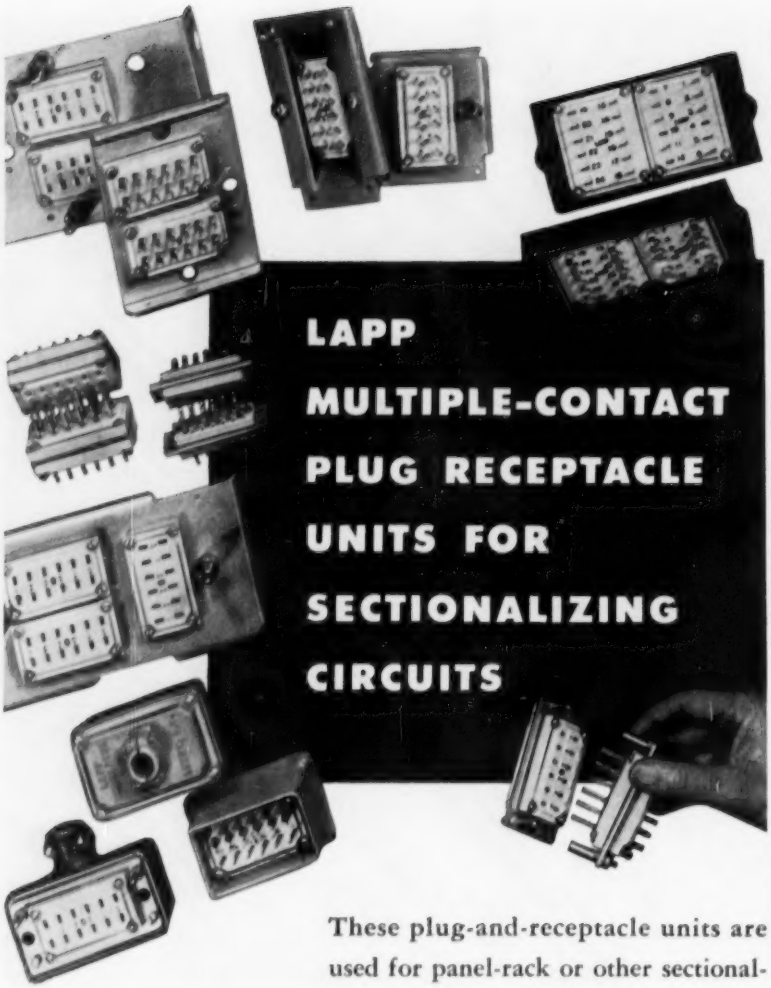

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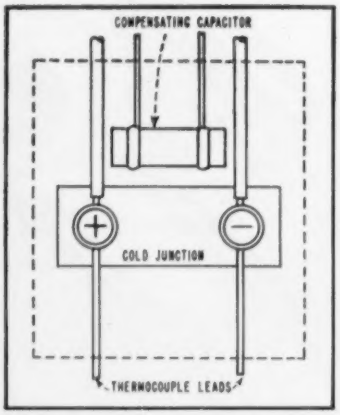

FIG. 3—Arrangement of the cold junction

ing and discharging capacitor C_2 in parallel with C_3 across capacitor C with the voltage of the standard cell.

Whenever the temperature varies, capacitor C_2 is rebalanced by the motor in response to the error voltage across C. Since C_3 is in parallel with C_2 and has a predetermined temperature coefficient the rebalancing necessary for C_2 will be a function of the capacitance of C_3 in terms of the cold junction temperature.

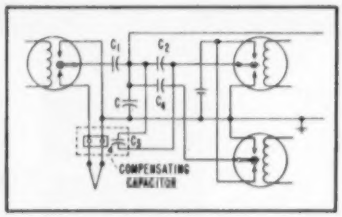

FIG. 4—Additional vibrator and capacitor explained in text

In Fig. 3 there is shown the physical arrangement of C_3 at the cold junction.

In Fig. 4 an additional vibrator is shown and an additional capacitor C_4 arranged to be alternately connected with C_3 so that C_3 and C_4 are in series with each other and with the standard ceil to oppose the charge on C_1 by the difference in charges on C_3 and C_4.

When the thermocouple voltage drops to zero and there is no charge on C_1 the balancing adjustment of C_3 will make the charge equal to that of C_4. A negative voltage will result in a smaller charge on C_4 than

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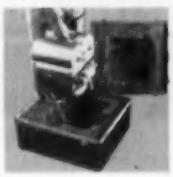

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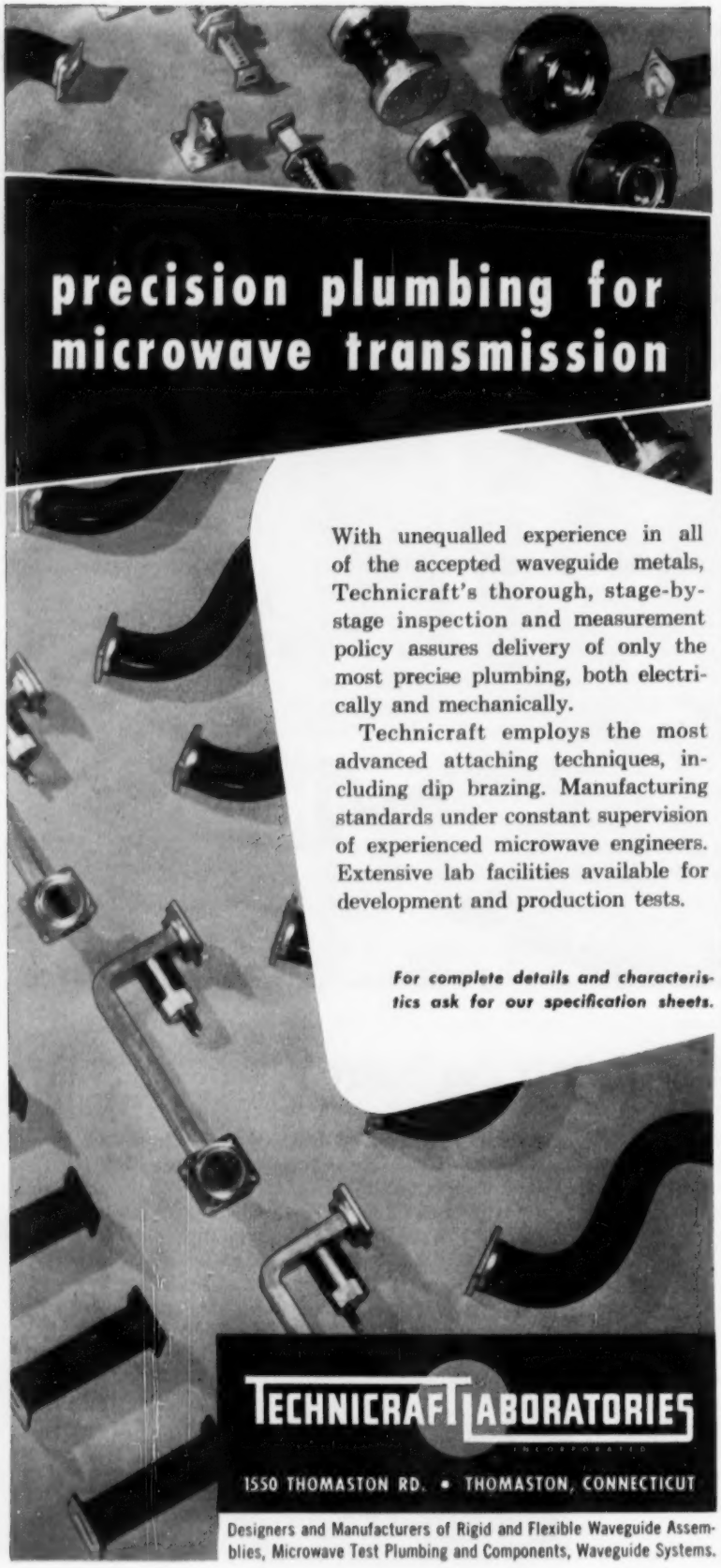
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C_3 and a positive voltage the reverse condition. In either case C_3 will perform the same compensating function previously described.

Diode Gate

Patent 2,685,039 for "Diode Gating Circuits" was awarded A. D. Scarbrough and E. E. Bolles of the Hughes Aircraft Company. The patent is assigned to the company.

In the past various diode gating circuits have been devised that normally pass pulses of a particular level that coincide with control pulses at a particular level but inhibit the passage of pulses that are not coincident or are coincident with some other lower level of control pulses.

The problem faced by engineers employing the prior art circuits was that they were ineffective at high speeds and any attempts to improve the operation so as to obtain fast turn-on and turn-off of the gates resulted in excessive loading of the signal sources. Either defect limits the effectiveness of diode gates.

These inventors claim to have devised diode gating circuits that overcome the above disadvantages.

According to this invention, as shown in Fig. 5 and 6, a diode is interposed between the input and output terminals of the gating cirsuit. The diode conducts only in the forward direction from the input to the output terminals. A d-c reference potential is applied to one diode electrode while the other is varied in accordance with the incoming signals from the control pulse source.

By arranging the biasing potentials so that the diode is backbiased for all potential values of the control signal other than the passing potential, the gating circuit passes only those pulses that occur simultaneously with the passing potential of the control signal.

The circuit of Fig. 5 illustrates an arrangement in which the gating circuit passes negative pulses when the potential of the control signal is at a low voltage level. Here the diode anode is connected to the reference potential source. The reference potential is substantially equal to the low voltage level of the control signal, so that when the control signal is at its low level the

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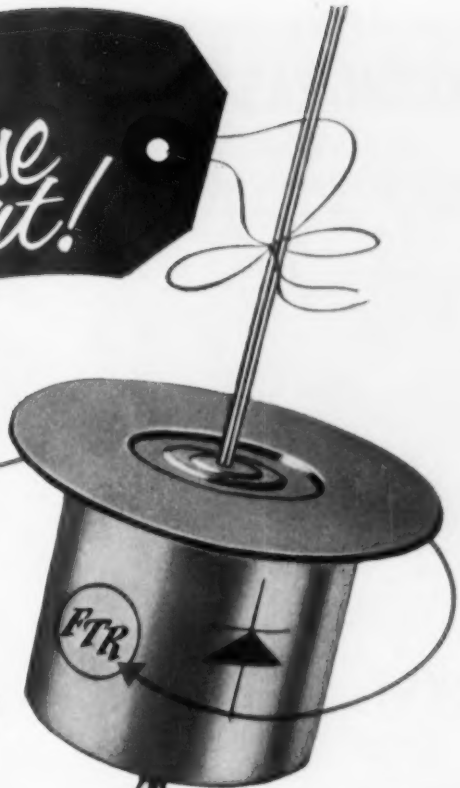

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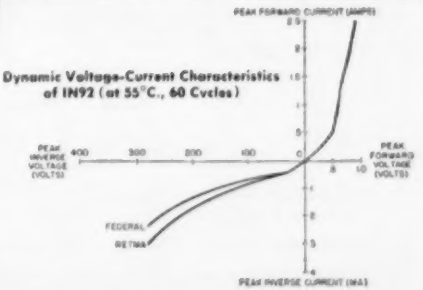

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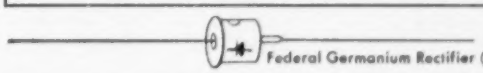

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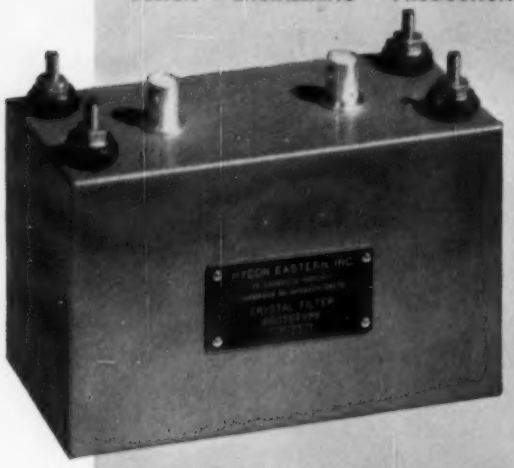

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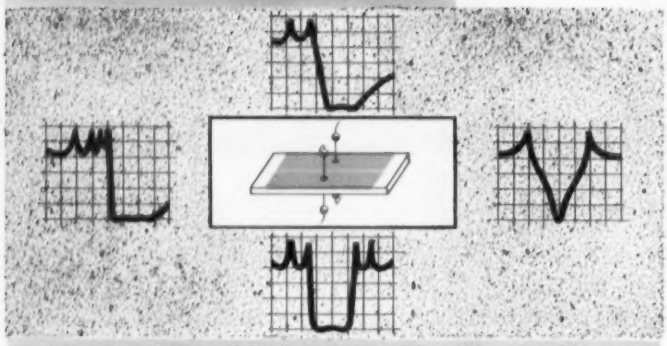

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negative pulses are passed by the diode. When the control signal is at a higher level the diode is back-biased and blocks the pulses.

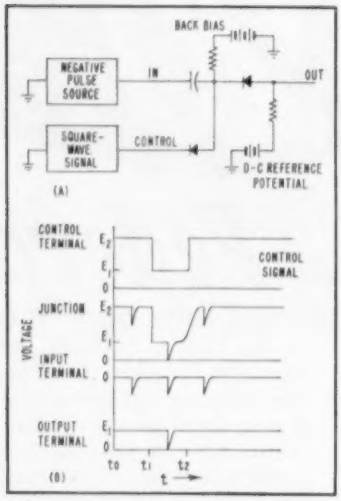

FIG. 5—Connections (A) and waveforms (B) for negative pulses

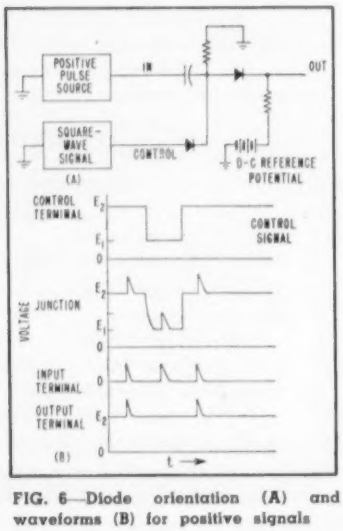

FIG. 6—Diode orientation (A) and waveforms (B) for positive signals

In Fig. 6 the passing diode connection is reversed. Here the gating circuit passes positive signals when the potential is at a high voltage level. The reference potential is connected to the cathode of the passing diode. The voltage of the reference potential is equal to the high voltage level of the control signal. Positive pulses are passed when the potential of the control signal is at a low voltage level.

The pulse diagrams of Fig. 5B and 6B clearly illustrate the operation of these diode gating circuits.

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Edited by JOHN MARKUS

Punched Slots in Back Cover Anchor Built-in TV Antenna

INSULATED wire used to form a dipole antenna is uniquely attached to back covers of tv sets by looping through C-shaped punchouts in the covers, in a technique used in Emerson's Jersey City plant. Only two staples are needed to anchor the antenna.

As the first step, the operator places an empty board on a slanting wood frame resting on the bench. Precut wires for the antenna are stored on metal straps projecting upward at the back of this frame. Picking up the first wire, she temporarily anchors its spade-terminal end between the turns of a coil spring that is fastened on the left side of the frame. In four quick movements, she pushes a loop of this wire down into each of the four punchouts in turn, pulling the wire taut each time.

The procedure is repeated for the second wire, which crosses the first at the first punchout. The loose ends of the two wires are then stapled to the pressed-wood back cover with an air stapler made by Duo-Fast Fastener Corp., Franklin Park, Ill. A ¼-inch thick strip of aluminum crosses the opening in the wood frame directly under the stapling locations, to serve as an anvil or backing plate for the stapler.

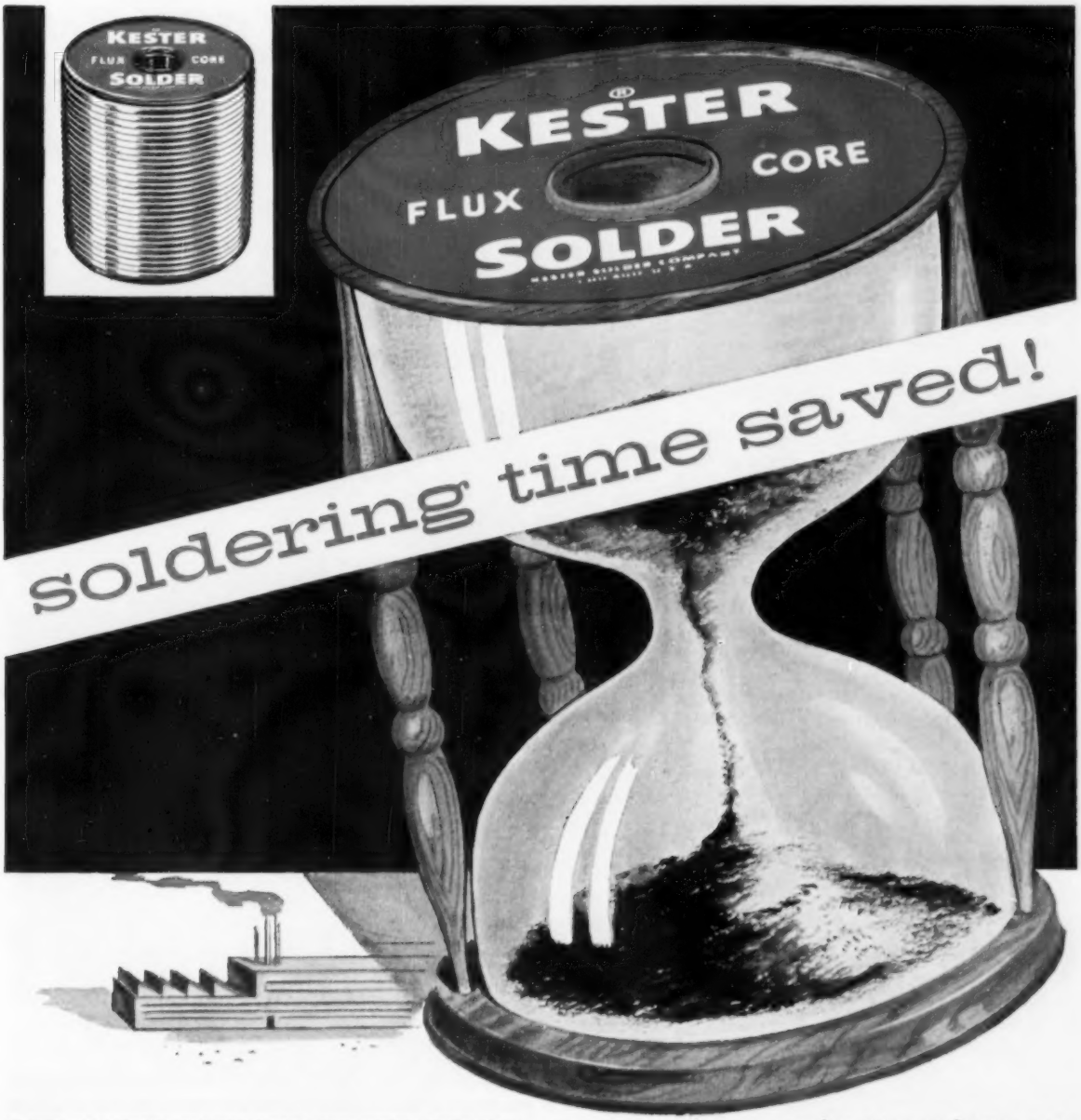
Pulling antenna wire taut after inserting loop of it in C-shaped punchout in back cover. Air stapler is suspended conveniently within reach overhead for use in anchoring ends of leads after threading operation

Tool Spreads Lugs of Socket on Etched Wiring Board

Placing tool over center pin of socket after inserting socket from other side

Method of holding tool while rotating wiring board, for spreading lugs

A QUICK spin of a simple screwdriver-like tool spreads socket terminal lugs out flat against etched wiring board after the socket has been inserted in the punched holes. The tool is used in Emerson's Jersey City plant during assembly of a table model radio using an etched wiring panel. The operator inserts a socket in the terminal holes with correct orientation, places the hollow-shaft tool over the socket center-pin with the wing of the tool at the missing-pin position, then presses straight down on the tool with one hand while rotating the board with the other hand. During this operation the lugs are flattened out one by one to anchor the socket and bring the lugs into optimum



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positions for dip-soldering.

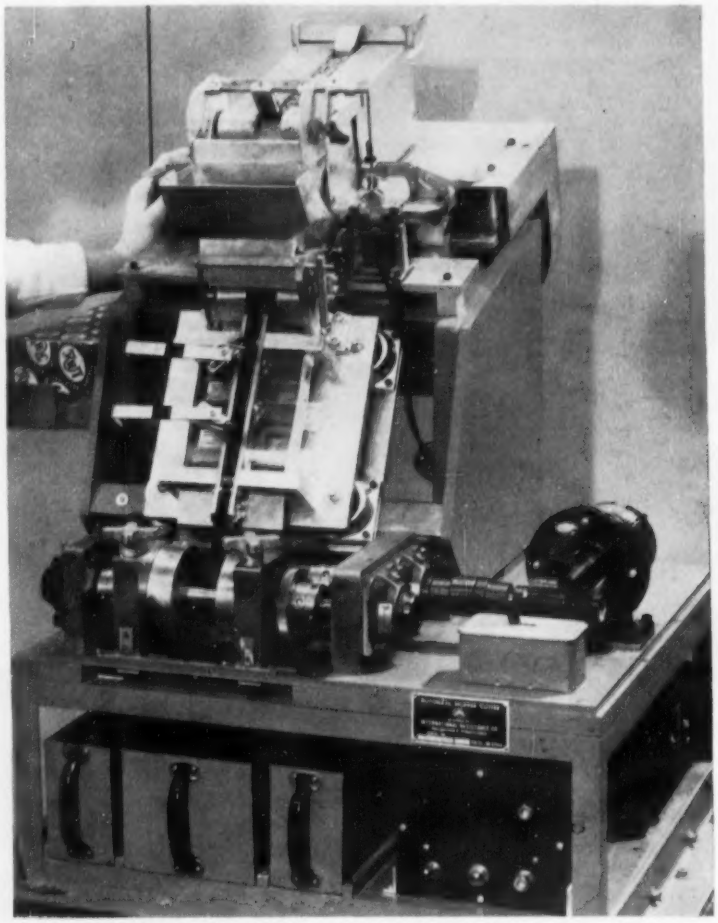
The tool was made by sawing off the socket of a hollow-shaft spin-type socket wrench, then brazing the lug-flattening wing onto the end of the tool.

This tool greatly reduces the time required for manual assembly and clinching of sockets on wiring boards, pending the arrival of automatic assembly machines for this purpose.

Hopper-Fed Automatic Lead Cutter for Carbon Resistors

LEADS of carbon resistors are cut to desired lengths at speeds of 30,000 resistors per hour by the new automatic hopper-fed lead cutter developed and built by International Resistance Co. Operation is automatic once the standard IRC Automation Package of 2,500 resistors has been loaded into the holder at the top of the machine. Trimmed resistors drop into one tote box underneath and the cut-off leads drop into smaller tote boxes on each side.

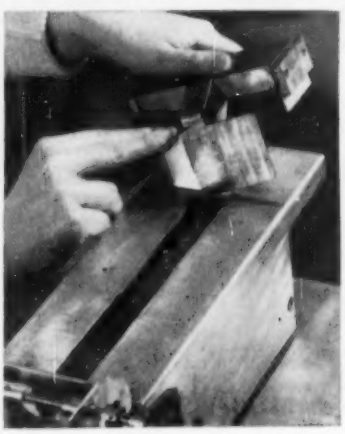
The loading operation involves sliding an opened package of resistors into the holder, removing the vertically ribbed cardboard spacers from the sides of the carton, then placing metal plates over the top of the carton and anchoring them with holding clamps. These plates prevent the resistors from pushing up out of the box under the force of the pusher-type unloading plate that is next inserted in the far end of the carton. This pusher plate is attached to a heavy weight. The entire carton holder slants forward and is subjected to a shaky motion by an electric motor and eccentric cam underneath. The pusher plate thus moves down during unloading through the combined forces of gravity and shaking motion.



Latest model of automatic resistor lead cutter. Motor on base at right drives cutters

How It Works

When the machine is started, the resistors are pushed out over the edge of their package through an oscillating gate into a funnel from which they emerge transversely in single file into the downward slanting hopper that brings them through the cutting blades. Two light sources direct beams across this hopper to phototubes below for controlling the flow of resistors into the hopper. When the resistor level in the hopper is high enough to block the upper light beam, the carton unloader gate closes and remains so until the re-



Inserting weight-loaded pusher plate

Inserting full carton of resistors

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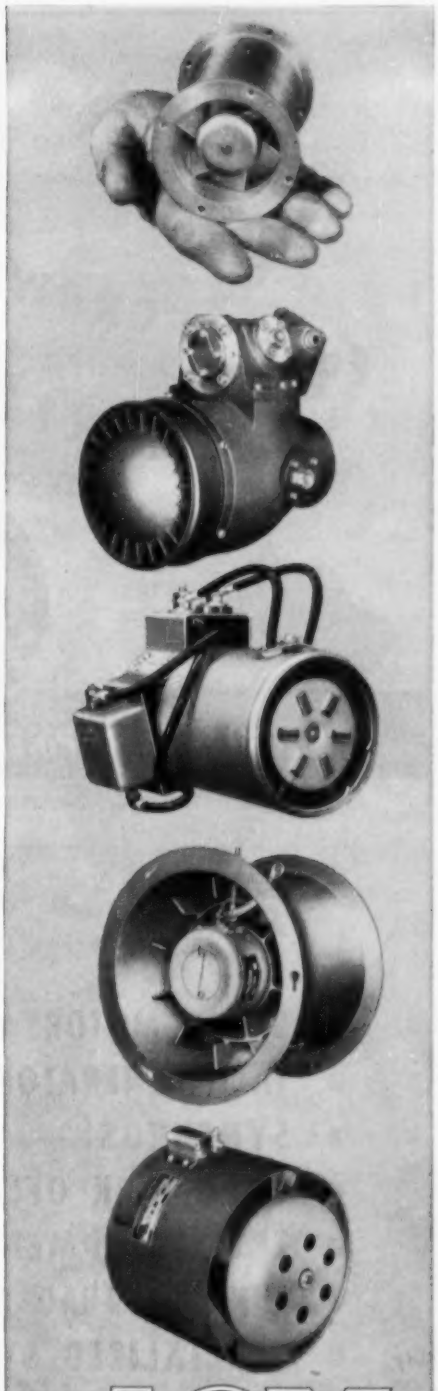

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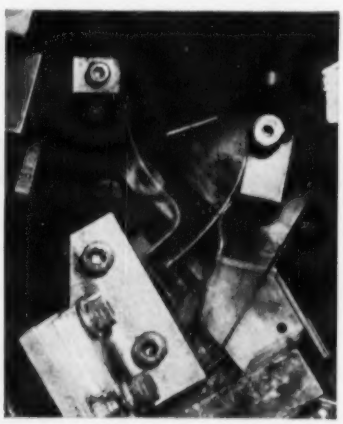
Pushing down clamps to hold top plates over carton of resistors. Solenoid at bottom pulls down intermittently when resistors are called for, holding finger-like gate open over hopper for about 1/3 second at a time. This allows up to seven resistors to come up over edge of carton and drop into funnel below

sistor level in the hopper falls below the lower light beam. This then serves to open the gate to initiate the next feed cycle.

Zigzag slots in the side walls of the hopper, through which the resistor leads project, help to keep the resistors in a horizontal position as they come down. The hopper brings the resistor leads between the two pairs of cutter wheels. The rear wheel of each pair has teeth, to insure positive feed of the leads down through the cutters. The front wheel overlaps the rear slightly to give the desired shearing action. Each pair of cutter wheels is mounted on a frame that can be



Side view of funnel into which resistors drop from carton, for feeding into top of hopper one at a time. Transparent side plates allow operator to watch for jams

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For Variable Capacitors
Tuners
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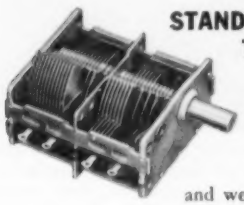
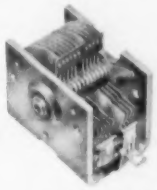
The experience of Radio Condenser in producing tuners and variable capacitors to individual requirements has consistently proved its value to manufacturers through the right combination of quality and cost. However unusual a problem may be, chances are that R/C specialists have faced a similar problem and solved it.

The products shown on this page are only a brief sampling of units designed, engineered, and manufactured by Radio Condenser. A more complete description of products in each category is given in our catalog, available on request. Or, we will be happy to arrange a direct interview with a Radio Condenser Engineer at your convenience.



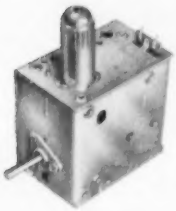
STANDARD HOME RADIO TYPE CAPACITORS

R/C units cover every standard application, including AM-FM receivers. Each is a product of high quality, performance-proved, and well adapted to rapid, low cost quantity production.



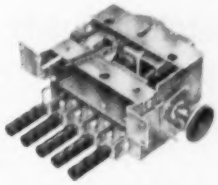
CAPACITORS FOR LIMITED SPACE

Among the most recently announced R/C developments is a miniature variable capacitor for transistorized radio receivers, also adaptable to color TV phasing control. R/C accomplished important reductions in size with no sacrifice of stability or calibration accuracy.



UHF AND VHF TELEVISION TUNERS

R/C has provided tuners for major TV manufacturers since the earliest days of commercial TV. While most such tuners are secret designs, R/C has recently developed low cost standard tuners in several styles for UHF and VHF TV.



AUTOMOTIVE RADIO TUNERS

Approximately one-third of all American automobiles are equipped with R/C tuners. Because every automobile radio tuner is an individual case, R/C custom manufacturing experience is an important asset to the radio manufacturer in this specialized field.

STANDARD CAPACITORS FOR SPECIAL APPLICATIONS

Always an important part of R/C activities, design and manufacture of variable capacitors of a special nature are handled by a special division. Products include units for every type of military service, test equipment, etc.

ELECTRO-MECHANICAL ASSEMBLIES

As a contract manufacturer of electromechanical assemblies for industrial and military electronic equipment, automatic data processing systems, etc., R/C also offers engineering assistance in development and modification, leaving you completely free of production worries and details. Complete information on this well-qualified division is available on request.

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10 to 500 watts

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MODEL 164

Quickly measures incident or reflected power, simplifies matching loads to lines

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Because of its compact size and wide range, Model 164 is ideal for portable applications (mobile, aircraft, etc.) as well as laboratory use. It is supplied in a sturdy carrying case (one or both plug-in elements supplied as ordered) and both meter and directional coupler may be removed from the case for remote monitoring. The monitor may be equipped for most connectors normally employed with 50 ohm lines. A twist of the wrist selects incident or reflected power, or any power range, without requiring removal of power. No exchange of plug-in elements is necessary to read low levels of reflected power.

TENTATIVE SPECIFICATIONS

Power Ranges: 10, 50, 100 and 500 watts full scale direct reading

Accuracy: ± 5% of full scale.

Insertion VSWR: Less than 1.08.

Frequency Ranges: 25 to 1,000 mc. Two plug-in elements.

Low Frequency Elements: 25 to 250 mc.

High Frequency Elements: 200 to 1,000 mc.

Impedance: 50 ohm coaxial line.

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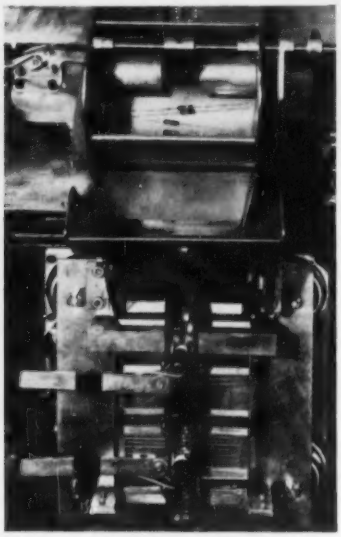
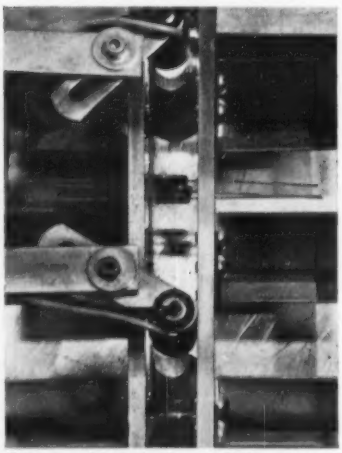
slid in or out simply by loosening a knob on top. All four cutters are driven by a single electric motor through a reduction gear and appropriate auxiliary gearing that gives a cutting speed of about 15 rpm. Pointers on the cutter supports move against a scale on the bed of the machine, calibrated to indicate lead length. Machine settings can thus be changed in a matter of minutes.



Front view of cutting machine, showing resistors dropping into funnel at top. Lamps, supported on metal straps below, direct light beams through resistors in hopper to phototubes behind



Closeup of hopper down which resistors slide when called for by photoelectric feed control. Lucite rods running to the phototubes can be seen behind lamps

A Syntron vibrator is mounted under the hopper to produce a smooth downward flow of the resistors even when operating at the

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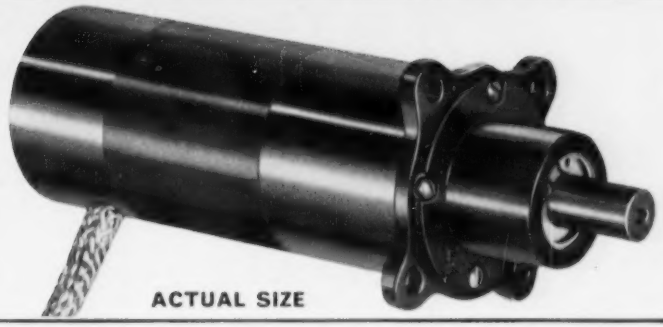

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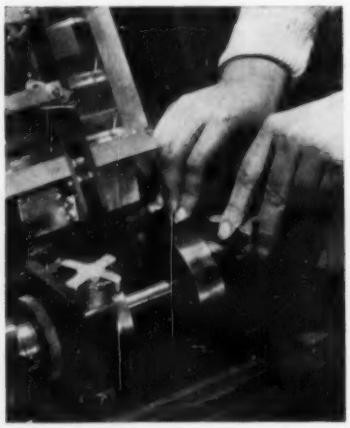

Loosening locking knob for right-hand pair of cutters. Scale at bottom center indicates lead length to which cutters are set

maximum speed. The mounting plate of the hopper is shock-mounted to keep this vibration independent of that which acts on the carton unloader.

When the photoelectric control system calls for resistors, the feeder gate is opened and closed at the rate of about 50 times per minute. The gate solenoid holds the gate open for about $\frac{1}{3}$ second each time, allowing from two to seven resistors to dribble through. The opening action occurs an average of six times for each resistor call by the phototubes.

Since the hopper is under vibration, neither the lamps nor the phototubes are mounted on it. The lamps are on brackets that come up around the vibrating plate to the front of the hopper. The phototubes are mounted on a fixed plate at the rear of the vibrating plate. Lucite rods are run through holes in the vibrating plate to bring the light beams to the phototubes.

Masking and Fluxing for Dip-Soldering

TO PREVENT uneven buildup of solder around mounting and grounding holes of the etched wiring board used in Emerson's home radio, tabs of Scotch masking tape are placed over these holes before applying flux with a paint brush and dip-soldering in the firm's Jersey City plant.

The tape is cut on an automatic

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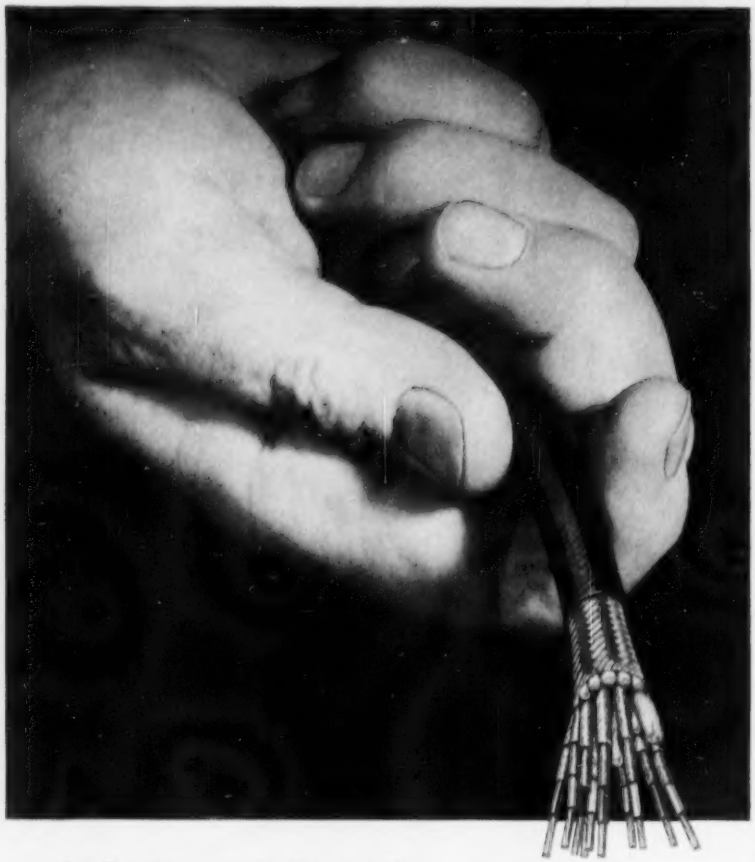

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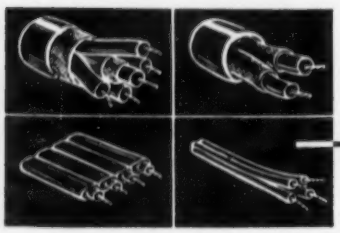

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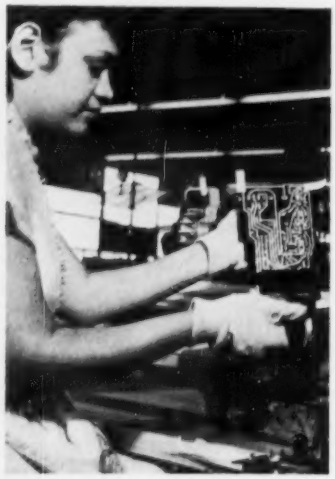

Method of holding finished wiring board, after masking its corners, for applying activated rosin flux with ordinary paint brush

dispensing machine that rests on a shelf just behind the slide-along line for these boards. A downward pull of the lever brings out two cut pieces for easy pickoff and transfer to the board. Another pull gives two more pieces to complete the masking of the four mounting holes on a board.

Flux is applied by brushing vigorously in two directions with an ordinary paint brush. The board is then placed on an egg-crate partition, fluxed side downward, to prevent the flux from running into parts mounted on top of the wiring board.

The four masking tape tabs are intentionally long so that they can be pulled off easily after dip-soldering by an operator wearing heavy gloves.

Automatic Sorting of Paper Capacitors

COMPLETELY automatic testing and sorting of capacitors is achieved with a new air-operated machine developed by Industrial Instruments, Inc., Cedar Grove, N. J. The tester makes high-voltage breakdown tests between leads, between leads and can, and then sorts capacitors by predetermined tolerances in up to eight categories at the rate of approximately one capacitor per second. The equipment is so synchronized that when set up to predetermined standards unskilled labor

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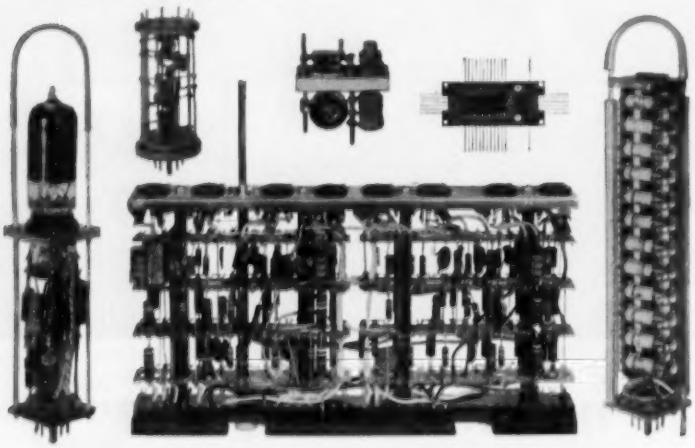
The Electro-Mechanical Division of Erie Resistor will welcome the opportunity to consult with you on the possible economies to be gained through the use of ERIE assemblies.



Typical ERIE Electronic and Mechanical Assemblies

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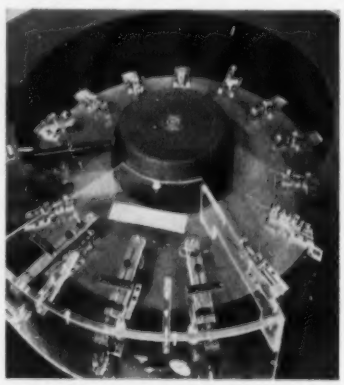
may operate it with no difficulty.

Capacitors of the coaxial lead type may be tested with or without leads. Other types may be tested through special test fixtures. The capacitors are loaded by dropping into a loose-fitting V-block arrangement as they pass the operator. This positions the units so contact

Method of loading capacitors on turntable of automatic tester. After testing, these are automatically ejected into approximate sorting or reject bins



High-voltage test stations are in foreground on turntable and eight sorting stations are at rear. Solenoid-operated pusher flips up V-block to toss capacitor into correct bin, as at rear center

can be made at later positions, where spring blades under overhead terminal strips push the capacitor body down.

The first test stage is a high-voltage terminal-to-case breakdown test, the second is a terminal-to-terminal test and the third discharges the capacitor through a current-limiting resistor. All units showing breakdowns in either of the two high-voltage tests are automatically rejected into a bin by a memory system after discharge.

The next eight stages are tolerance selections according to capacitance. Eight bins are provided for

Battery Of Leesona No. 108 Coil Winders installed in the plant of Acme Electric Corporation, Cuba, N. Y. The most advanced hand-feed coil winders ever designed, Leesona No. 108's wind 4 to 30 paper insulated coils in stick form simultaneously. Note how conveniently the controls are located for quickly changing to a new coil spec — one of many advantages for speeding production on long or short runs. Inset shows an Acme Electric precision-wound luminous tube transformer which features coils that provide 18 MA 12000 volt secondary.

At ACME ELECTRIC...Leesona coil winders provide new production advantages

Manager credits No. 108 machines with vital share in increasing output

Transformers made by Acme Electric Corporation are used in a wide range of equipment, including radio, TV and other electronic apparatus, rectifiers, neon signs and fluorescent lighting. To meet increased demands for its products, Acme Electric recently replaced old hand-feed coil winding equipment with new Leesona No. 108 Hand-Feed Coil Winders. Plant Manager W. F. Koubek of Acme Electric sends the following report:

"Leesona No. 108 Winders are doing a great job of expanding our production. For short runs on a wide variety of coil types, the quick-change features of these machines are unequalled. We're getting excellent results in both quality and quantity from the accuracy, easy operation and fast winding speed of our new 108's."

Many similar reports prove how Leesona No. 108 Coil Winders — the most accurate, flexible and economical hand-feed winders ever developed — are bringing important benefits that can save *you* time and money, too.

Get the Whole Story

The coupon below will bring you complete facts on Leesona No. 108 Coil Winders, together with other helpful coil winding information. Why not check and mail it today?

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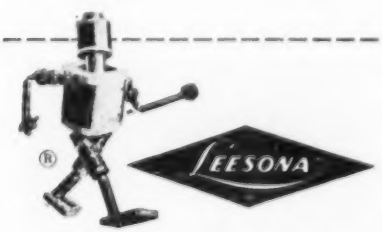

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Voltage Range:	0-100 Volts DC
Resolution: At least	50 microvolts between 0 and 1 volt
	500 microvolts between 1 and 10 volts
	5 millivolts between 10 and 100 volts
Absolute Accuracy:	± 0.1% of reading
Input Impedance:	Infinite at null

Model PVM-4

Voltage Range:	0-600 Volts DC
Resolution: At least	5 millivolts between 0 and 10 volts
	50 millivolts between 10 and 600 volts
Absolute Accuracy:	± 0.1% of reading
Input Impedance:	Infinite at null

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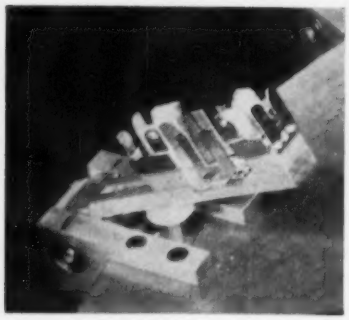


Hinged V-block is pushed up by plunger on under-table solenoid to toss capacitor out into bin

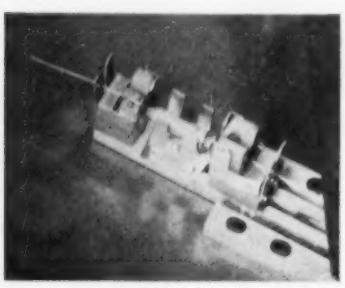
these stages. The system can be set up to use four or eight tolerance stages, with an increase in speed for four-stage testing.

All high-voltage stages are protected by a clear Lucite guard and interlocking switches. With minor modifications, the system may be adapted to testing of resistors, inductors or any combination of these.

The memory system under the metal housing at the center of the table uses the storage of voltage on a capacitor. The correct capacitor in the memory bank is charged at the test station; the bank of capacitors rotates with the indexing table and this voltage is used to fire a thyratron at the correct eject station. Capacitors are ejected by an air-operated plunger which is controlled by a solenoid air valve in the plate circuit of the thyratrons.

The test voltages in the breakdown tests are continuously variable from 100 to 5,000 volts. The capacitance measurements range from 40 μf to 5 μf with an accuracy of plus or minus 0.3 percent. Setup time is kept to a minimum. An insulation resistance test station may be added if desired.

The air-operated, electrically controlled table is satisfactory for the



Capacitor in V-block fixture on turntable

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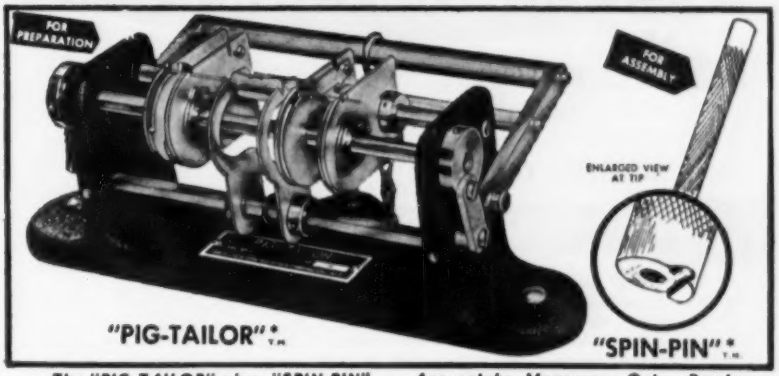

The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:

1. Uniform component position.
2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits.
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

PIG-TAILORING eliminates:

1. Diagonal cutters.
2. Long-nose pliers.
3. Operator judgment.
4. 90% operator training time.
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6. Broken leads.
7. Short circuits from clippings.
8. 65% chassis handling.
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Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. E9-P

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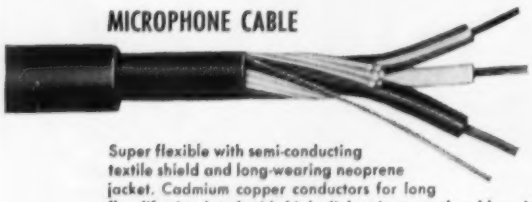

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Custom-built to customer's requirements. Using either standard cordage or cord designed to fit your particular application, Whitney Blake can furnish regular line cords or special purpose cords having attached or integrally molded rubber or Plastite fittings.

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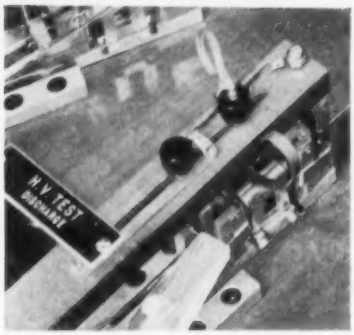

Test station on turntable

lower operating speeds but on faster equipment the table is driven by a variable-speed electrical drive through a Geneva indexing mechanism. This drive operates at higher speeds with a minimum of shock.

Radio is Dip-Soldered with Tubes in Sockets

INSERTING the miniature tubes in the sockets of a printed-circuit home radio before dip-soldering allows for proper positioning of tube pins in sockets. The procedure contributes to product quality in the Jersey City plant of Emerson Radio and Phonograph Corp. When soldering was done before tube insertion, these clips were sometimes suffi-

Asbestos gloves and heavy canvas sleeves protect operator during dip-soldering. Lucite shield in front of face gives further protection. Handle of dross-wiping blade can be seen at left of operator's left hand

ciently out of position to make insertion of tubes difficult or impossible.

The cycle used for dip-soldering is 9 seconds at 460 F. Just as a radio is lowered into the solder, the operator presses a foot switch to start a preset timer. This automatically rings a bell at the end of 9 seconds to signify the end of the soldering interval.

Before each soldering operation,

"She not only thinks—she even dreams!" These are the words which express the full implication of NIKE, the new guided missile that has a vital part in defense planning. NIKE seeks, locates, and destroys an airplane... another missile... anything that flies. The deadly reliability of her guidance system depends in part on *SYNCHROS* which translate electrical impulses into positioning data.

NIKE

Based on their experience, research facilities, and performance in volume production, the Precision Components Division of Norden-Ketay was chosen by Western Electric Company, prime contractor, to develop and produce special *SYNCHROS* for NIKE. Norden-Ketay also serves most of the other leaders in automatic control.

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"Winged Victory" is the familiar name of this Greek statue of NIKE, goddess of victory, found at Samothrace, (circa 300 B.C.). Her name (pronounced 'Ny-Key') was selected by Army Ordnance as most appropriate for the ground-to-air missile developed for them by Bell Telephone Laboratories. Norden-Ketay is proud to have been chosen as an integral part of the team which produced NIKE.

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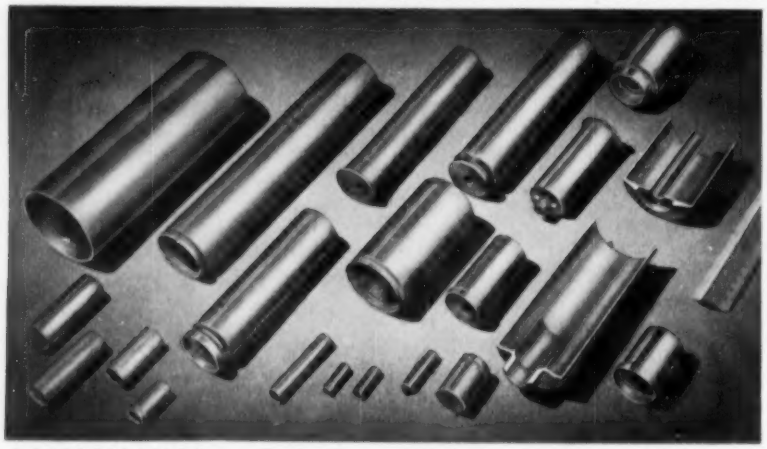

ALUMINUM • ZINC • LEAD • TIN • SILVER

the operator moves a stainless-steel wiper blade across the surface of the solder to remove dross. This blade has wood handles at each end that rest on and slide along the sides of the solder pot, so that the blade can be left in the pot at all times.

Welding Taps of Precision Windings

PRODUCTION WELDING of tap lead wires to precision windings of 0.0007 to 0.025-inch-diameter resistance wire is being achieved with an electronic tapwelder made by the Hanjohn Co. of Pasedena, California. Terminal definition is maximum, since only one turn of the element may be selected for termination.

The welding technique involves a capacitor discharge at a specified voltage through a circuit which includes both the particular element turn to be tapped and the tap lead wire itself.

The negative lead touches the designated element turn. The positive lead consists of surgical tweezers holding the lead wire which is to be welded thereon. The microsecond of arc resulting from depression of the foot switch and touching of the tap lead wire to the element turn causes a true arc-flow weld, fusing the two wires in a precise, homogeneous juncture.

Positioning of the positive lead on the element-turn to be tapped is achieved by either linear measurement, radial or arc measurement or electrically by a bridge circuit;

Method of using binocular microscope to aid in welding tap to single turn of resistance wire. Lamps held on microscope with rubber bands illuminate work area. Microscope base slips under wood fixture holding potentiometer

WHEN IT COMES TO LOW PRESSURES

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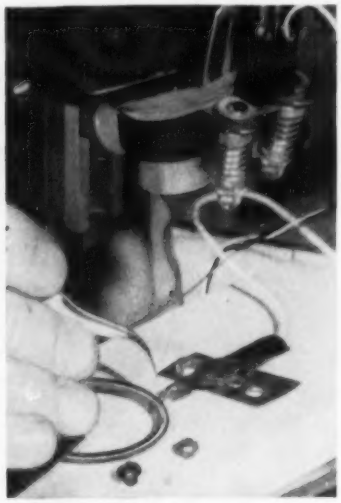


Turn to be tapped rests on negative electrode of welder. Tap wire is held in tweezer-type positive electrode

where probing is necessary to determine on which element turn the positive lead is making contact, the built-in continuity meter may be used.

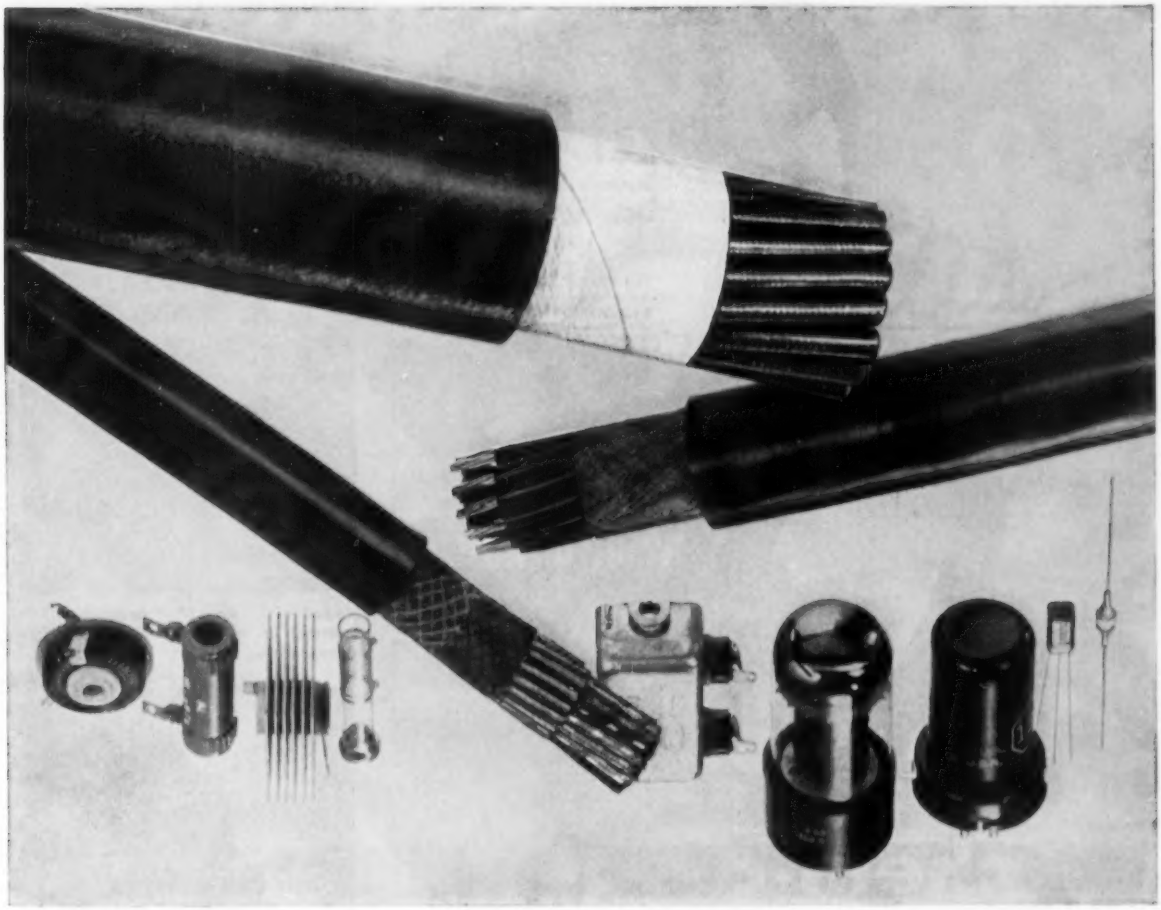
In anticipation of the microscope work generally necessary on the extremely small wire, the machine is provided with jacks for plugging in spotlight-type lamps that may be taped onto the microscope. Fracturability of the right-angle weld on very small wires is avoided in practice by applying a drop of adhesive to the completed weld.

Precise control of certain factors is necessary. Cleanliness of the weld area is imperative. Welding voltages and gage and alloy of tap wire for given gages and alloys of element wire are provided in chart form for commonly used precision resistance alloys.

Installing Electrolytics on Etched Wiring Boards

CONVENTIONAL electrolytic filter capacitors with flexible insulated leads are being successfully mounted on etched wiring boards and dip-soldered in Emerson's Jersey City plant. A capacitor-mounting clip riveted to the side of the gang tuning capacitor holds the electrolytic at such a position that its leads provide their own tension for staying in position during subsequent assembly of other parts on

Want more information? Use post card on last page.



In electronics... **cables are basic**

Proper choice of wiring material for electronic equipment involves a critical decision. As a component, it may well "make or break" product performance or design. Fortunately, there are guide posts to help you in the selection of a qualified supplier.

Look for essentials

Look, first, for *high quality*. Look for such essentials as full-sized copper, uniformly annealed and precisely stranded. Look, too, for insulations and coverings which have been proven to provide good workability and long-lived dependability.

Then, look . . . as *your* customers presumably do . . . for a supplier of responsibility. To qualify, such a supplier should have (1) a thorough knowledge of electronic wiring problems, (2) engineering and research ability in the development of special cable constructions and (3) complete manufacturing facilities of modern design for the production of specification or custom-built cables.

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For some 20 years we have served the electronic industry with complete satisfaction. Rome's high product quality and engineering ability have gained wide recognition wherever exacting standards of performance are a requisite.

Fully approved

Rome Cable products, commercial and military, are manufactured in strict compliance with the requirements of approval agencies.

With Rome engineering and manufacturing experience, you get full value from your electronic cable dollar. *We will be happy to serve you.* For more details, write for Bulletin TR-5.

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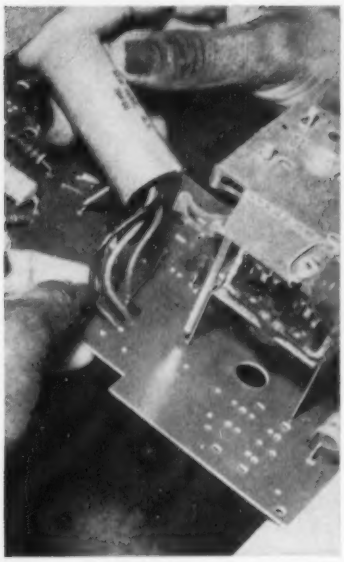
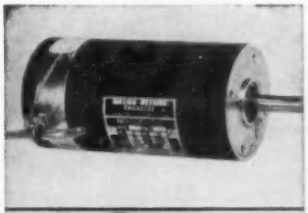
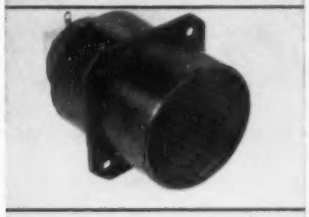
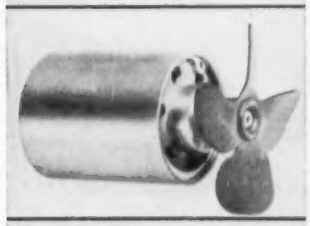
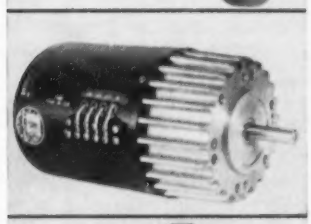
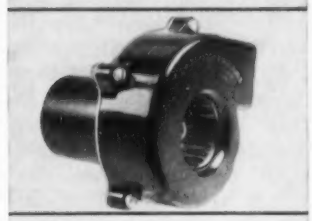
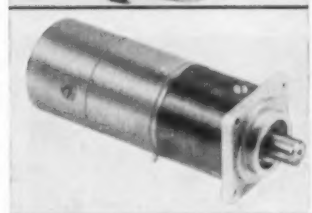
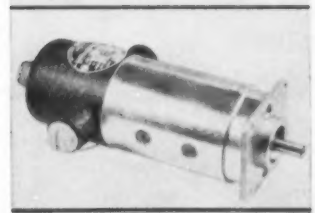
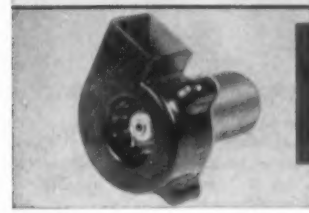


Method of holding filter capacitor while inserting its leads in punched holes of etched wiring board

Pressing capacitor into mounting clip after leads have been inserted in punched holes. Slide-along line with grooved hardwood ways permits insertion of parts having long untrimmed leads, which are cut and clinched manually by operators at end of this line

a slide-along assembly line for these home radio wiring boards.

Holding the capacitor in her right hand, the operator inserts its three leads one by one in the three punched holes allocated to them, then presses the capacitor into its mounting clip to complete the assembly. No preliminary prepara-

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9 REASONS WHY!

- die-cast aluminum housings for rigidity
- ball bearings throughout
- stainless steel through bolts
- bonded stators for greater strength
- full protection against humidity and fungus growth
- meet or exceed all AN specifications
- constant inspection and 100% performance testing
- continuing research program to improve techniques and manufacturing methods
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More than 50 basic motor designs, including axial and centrifugal blower designs, ranging from .001 to 2 HP, from 50 to 1,000 cycles, any voltage range, to fill virtually any specification. Please detail your requirements. Our engineers will make recommendations promptly. Write Executive Offices,
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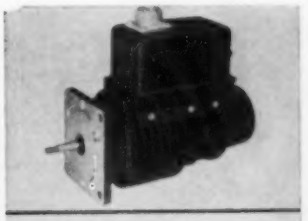
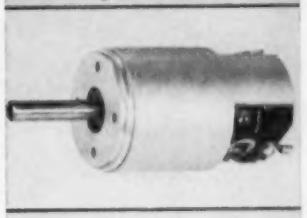
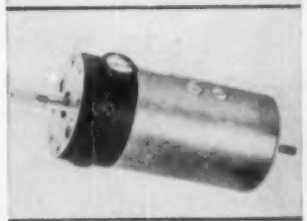
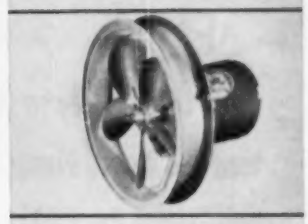
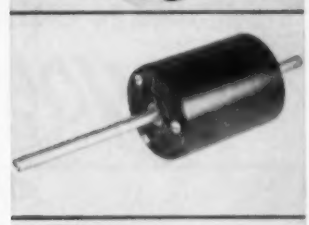
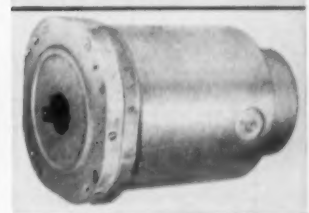
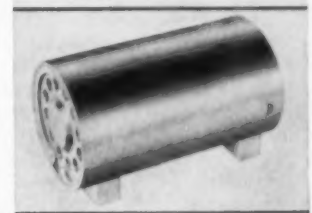
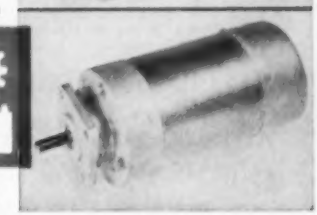









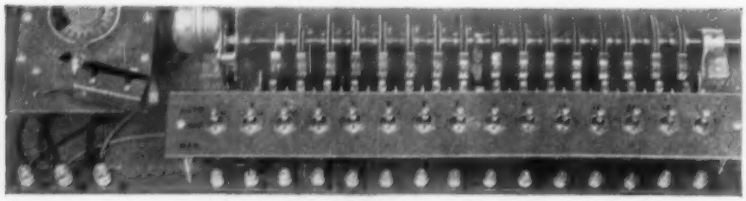
"The difference is reliability" • *Since 1888*

5558

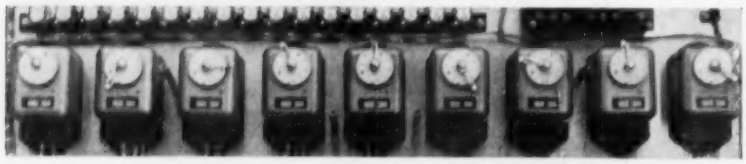
WESTERN GEAR

PACIFIC-WESTERN PRODUCTS | POWER TRANSMISSION GEARS • MACHINERY •

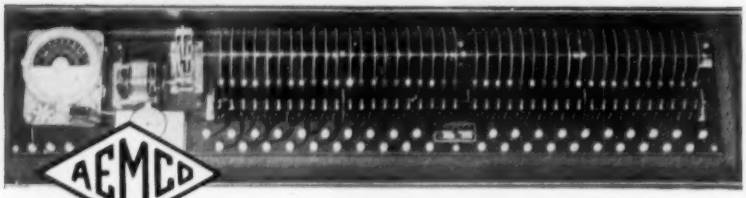
PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.) SEATTLE AND HOUSTON — REPRESENTATIVES IN PRINCIPAL CITIES



switching . . .



to automatic control?



has a complete line of relays, timers and time switches to assist *you*

Specialists in the control field for more than 30 years, AEMCO engineering offers you fresh, new ideas . . . ideas that save you money in automatic control . . . ideas that save you valuable time. Yes, AEMCO is selling service as well as a complete line of relays and both automatic re-set and sequence timers.

AEMCO

RELAYS

At AEMCO we specialize in both the design and manufacture of relays to your mechanical and electrical specifications. Should one of hundreds of stock AEMCO relays fail to meet your specialized requirements exactly, we will design and build a unit not only to meet, but to exceed those specifications.

- Open or can types
- Miniatures and sub-miniatures
- Power Relays
- Delayed make or break types
- Circuit control relays
- Current and potential relays

For detailed information on the complete AEMCO relay line, write for your copy of Relay Catalog H.

AUTOMATIC RE-SET AND SEQUENCE TIMERS

Now control that vital operation . . . automatically! Available in many different models with automatic or manual reset, AEMCO industrial time controls help eliminate waste . . . help speed up production. Variations are available on standard cycling models . . . dials are easy to read, easy to set.

- AR and MAR—Automatically re-cycles at end of cycle
- ARD and MARD—Re-cycles with an interruption of current
- ARR—Repeating cycle
- MARA—Two circuits—both closed and open. Circuits completely adjustable
- No. 400—Sequence timer. Momentary start—automatic stop or continuous cycling. Any number of circuits.

For detailed information on AEMCO industrial time controls, write for your copy of AEMCO's Time Control Bulletin.

AEMCO

AUTOMATIC ELECTRIC MANUFACTURING CO.

14 STATE STREET • MANKATO, MINNESOTA

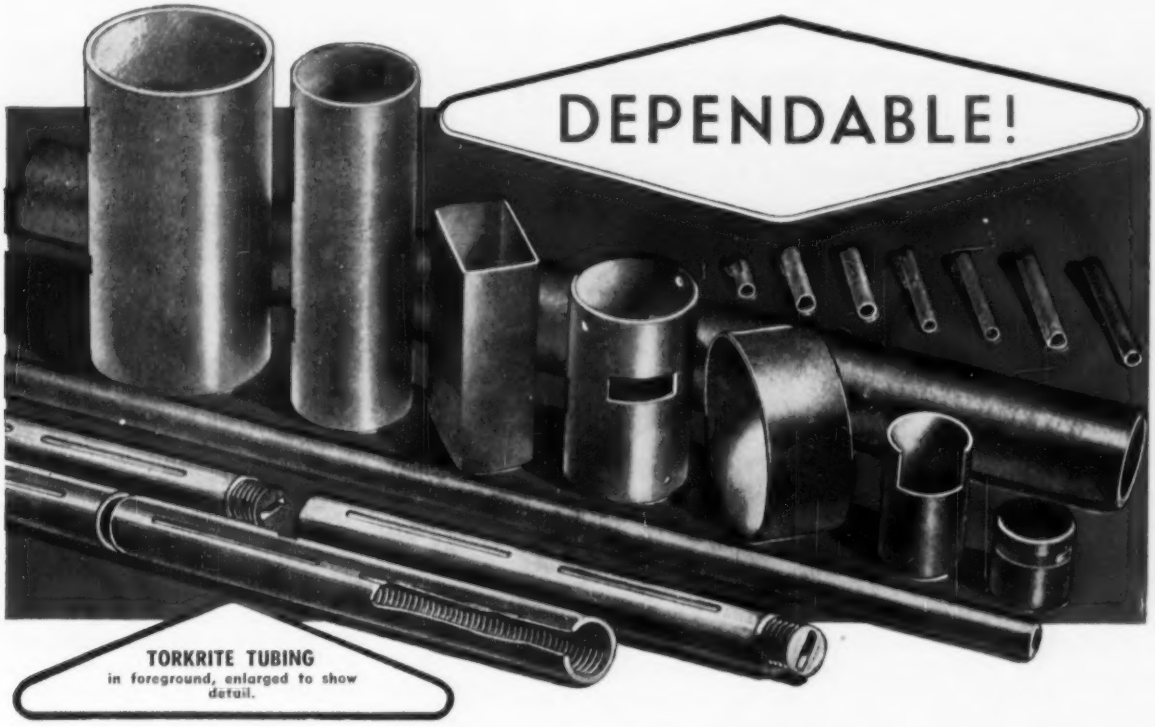
tion is required, since the units are purchased from the vendor with leads cut to the right length, stripped and tinned.

Cork Tape Cutter

ADHESIVE-BACKED cork tape used for cushioning at various points on the chassis and cabinet of an Emerson tv set is automatically cut to desired lengths by a special machine in the firm's Jersey City plant. The machine cuts through the cork without touching the protective cloth backing, so that the tape remains in strips for convenient transfer to the production line. There, the presence of the continuous length of backing strip makes it easy to remove the cork pieces one by one.

To start the operation, the operator loads a roll of tape of the desired width onto the removable pin that fits into slots in angle-iron uprights at the right end of the cutting board. The tape is threaded between idler rolls (since found unnecessary) and pushed through a guide slot up into the cutting wheel. Wheel slots are spaced ½ inch apart along the circumference, in which can be set Stanley single-edge blades. An Allen screw locks each blade in position. With blades in every three slots, the strips are cut into 1½ inch long pieces. Another cutting cylinder is available with slots ¾ inch apart along the cir-

Setup for cutting cork tape into pieces 1½ inches long. Metal protective shield for cutter, on bench at left, has been removed to show method of mounting blades in cylinder



TORKRITE TUBING
in foreground, enlarged to show detail.

★ ★ ★

DO YOU HAVE TORQUE PROBLEMS?

More and more electronic engineers are specifying this newly designed, internally threaded, embossed tubing.

Torkrite permits use of lower torque as it is completely free of stripping pressure.

With Torkrite, torque does not increase after winding. The heavier wall acts to prevent collapse and core bind.

Investigate this outstanding coil form!

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Write for your copy of the latest Clevelite brochure.

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CLEVELITE*

Laminated Paper Base Phenolic Tubing

is dependable because of its better quality . . . proven performance . . . high insulation . . . uniformity . . . inherent ability to hold close tolerances.

Also, prompt service and dependable deliveries!

These many advantages assure you of greater economy.

WHY PAY MORE? For Good Quality . . . call CLEVELAND!

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ABRASIVE DIVISION at CLEVELAND, OHIO
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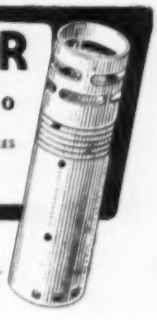

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CHICAGO AREA: PLASTIC TUBING SALES, 5215 N. RAVENSWOOD AVE., CHICAGO
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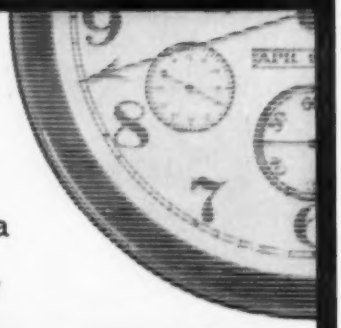
Want more information? Use post card on last page.

A GREAT NAME CONTINUES GREAT NEW ACHIEVEMENTS

Thomas A Edison

How Edison achieves extraordinary timing accuracy in a **thermal relay**



By calibrating each 501 Thermal Relay *after* hermetic sealing, EDISON provides unequalled timing accuracy — assures absolute production uniformity. Circuit designers can realize *all* of the benefits of a thermal relay without concern for changes in atmospheric pressure — or the problems of relay maintenance.

This exclusive method of calibrating, developed in the world-famous EDISON Laboratory, is just one of the features that have earned the EDISON 501 Relay an outstanding in-use record. A high degree of vibration and shock resistance, extreme light weight and typical EDISON construction ruggedness are but a few of the other features of the EDISON 501 Relay that lend it to such applications as these:

- **Sustained over-current or over-voltage protection**
- **Integration of pulses or intermittent current**
- **Improving sensitive contact operation**
- **General control use**
- **Cathode protection**
- **"Holdover" circuits**
- **Motor starting**

Send for complete information on the dependable EDISON 501 Thermal Relay — now.

Thomas A. Edison
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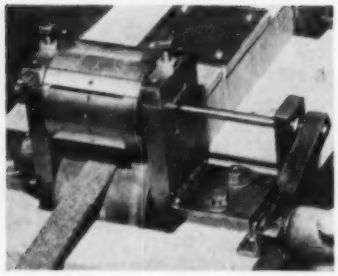
INSTRUMENT DIVISION • 54 LAKESIDE AVENUE • WEST ORANGE, NEW JERSEY



Details of cutting wheel

cumference, to give in-between lengths of tape.

A machined Bakelite wheel mounted directly under the cutting cylinder serves as a precision rotating anvil, as required for cutting through the cork without cutting the protective cloth backing of the tape.

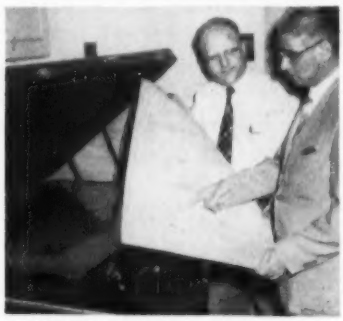
Turning the crank on a shaft of the cutting wheel serves to cut and feed the tape. An operator can cut an entire roll of tape in a few minutes.

Where narrower widths of tape are required, the standard ½ or 1-inch widths are run through a slitting blade on a separate cutting board first.

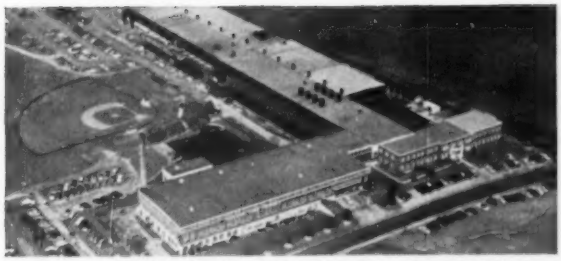
Printed Film Transparencies Reduce Drafting Time

A REDUCTION of more than 95 percent in time needed to produce engineering drawings has been achieved by General Electric in its Philadelphia plant. New and ingenious techniques in the use of photo-mechanical materials and processes now permit making in a matter of minutes a tracing which formerly took 6 to 18 hours.

It is merely necessary for the engineer or draftsman to prepare



Examining finished autopositive made from composite film transparency on printing machine



Main plant of Superior Tube Co. located near Norristown, Pa. Cathodes are also manufactured at the Superior Tube Co. plant at Wapakoneta, Ohio.

Johnson & Hoffman factory and office at Mineola, L.I. Electronic and mechanical engineering consulting services are available to all customers.

Superior Tube adds Johnson & Hoffman as new associate—broadens line

NEW PRODUCTION CAPACITY FOR TUBULAR PARTS: SEAMLESS, LOCKSEAM AND DEEP DRAWN

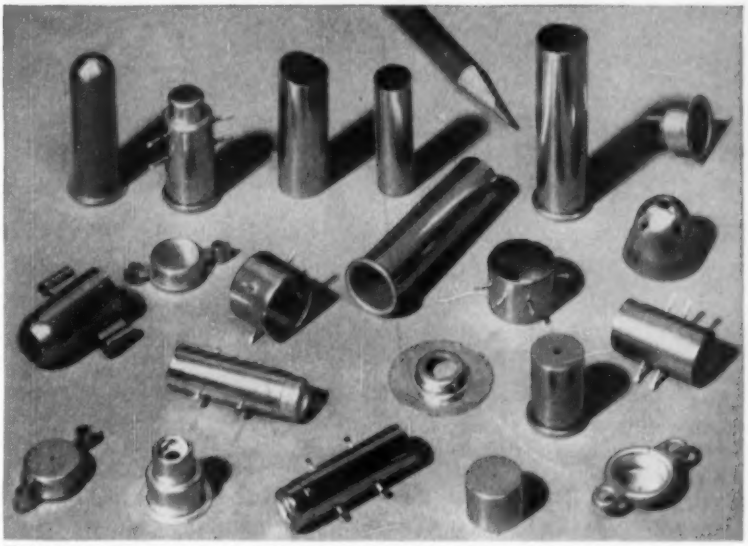
NORRISTOWN, Pa.—Superior Tube Company, world's leading independent supplier of cathodes for electron tubes, has just brought into its family the Johnson & Hoffman Co., of Mineola, L. I., with its personnel and manufacturing facilities.

Johnson & Hoffman supplies parts and subassemblies used in cathode ray guns to the major manufacturers of cathode ray tubes. It also specializes in general metal and mica precision stampings for other electronic applications.

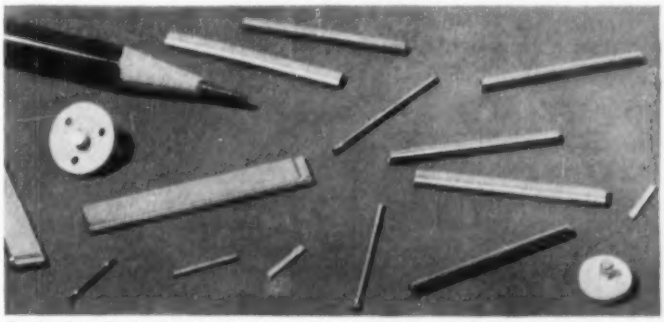
The new associate will continue to handle its own orders directly with customers, and will be operated by the same management people. Now, with the addition of these new facilities, Superior Tube Co. can offer a broader and more diverse line of products and services than has ever been available before from one source. Write for specific information on tubular parts you need. Superior Tube Co., 2500 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing



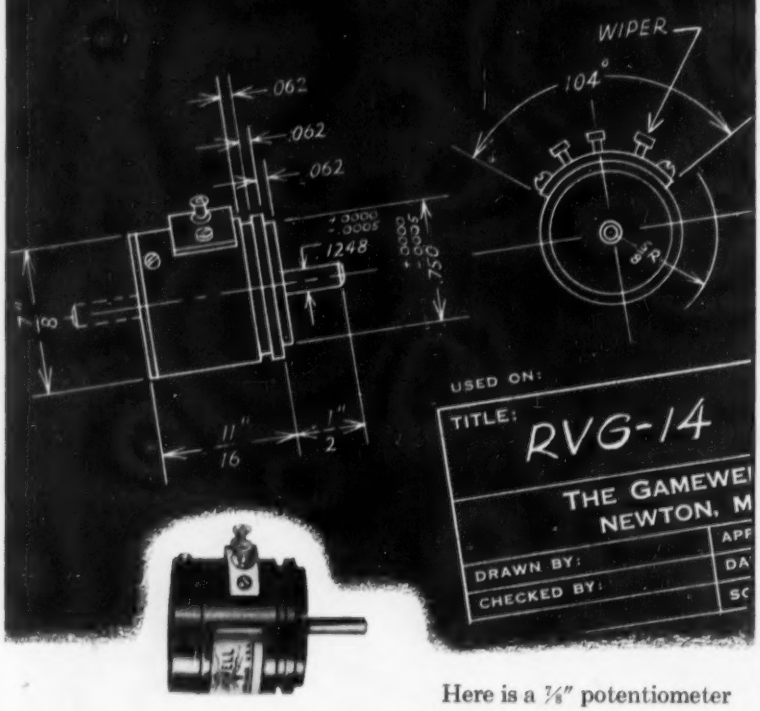
Tubular parts. Johnson & Hoffman anodes, grids and lens assemblies are produced on precision deep-drawing machines from high-quality strip material. Special processing produces high degree of smoothness and surface luster.



Cathodes. Typical electronic products of Superior Tube Co. New miniature disc cathode has significant space and power-saving advantages in cathode ray tube applications. Cathode sleeves are available to extremely close tolerances in Seamless, Weldrawn,* and Lockseam† form in any of a wide variety of cross-section shapes.

*T. M. Reg. U.S. Pat. Off., Superior Tube Co.
†Manufactured under U.S. patents

New 7/8" Precision Potentiometer by GAMEWELL



Here is a 7/8" potentiometer that offers you the extreme precision found in larger sizes of Gamewell Potentiometers.

Body is of anodized aluminum and the shaft is made of stainless steel. Kohlrausch type winding provides excellent linearity and the unit meets MIL-E 5400 specifications as they apply.

The unit can be modified for special mounting. Write for additional information about the new 7/8" type RVG-14 precision potentiometer.

THE GAMEWELL COMPANY
NEWTON UPPER FALLS 64, MASS.

GAMEWELL®

PRECISION POTENTIOMETERS

Manufacturers of Precision Electrical Equipment Since 1855

CONDENSED SPECIFICATIONS

Potentiometer Type No.	RVG-14
Diameter (inches)	7/8"
Rating (watts)	1
Torque, max. (ounce-inches)	0.25
Weight (ounces)	3/4"
Max. Resistance (ohms) ±5%	45,000
Min. Resistance (ohms) ±5%	25
Useful Angle (deg.)	354°
Min. Resolution (%)	0.06
Linearity (%)	±0.5

Multiple sections can be ganged; add ½" to overall length for each additional section. Better linearities can be obtained on special order.

a simple coded order for the blueprint section. This order embodies all necessary instructions for the preparation by a clerk of a composite film transparency, comprising reusable positive film overlays, from which a translucent auto positive is printed by conventional photo-mechanical methods. The auto positive, which thus becomes the original tracing, has many advantages. It is tougher than conventional tracing paper and can stand rough handling. It has sharper contrast with dense, crisp, black lines which permit high printing speeds. Erasures can be made quickly and easily by moistening the image and using a soft eraser.

A major advantage realized in use of this system is greater drafting accuracy with a saving in time of skilled engineers and draftsmen, due to the eliminating of a substantial amount of detailed sketching and checking.

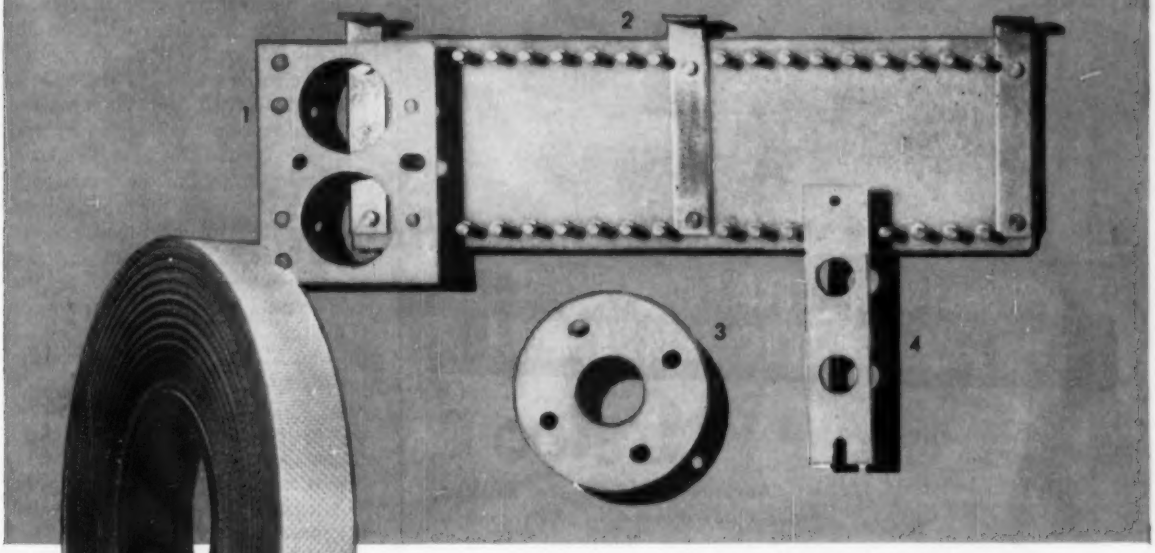
Wings on Chassis Support 24-Inch Picture Tube

THE SAME belt conveyors and the same chassis units serve for making 21-inch and 24-inch television receivers simultaneously in Emerson's Jersey City plant. For the 24-inch sets, metal wings are fastened to the chassis with an air gun and

Method of using air gun to insert self-tapping screw for attaching wing to chassis to hold 24-inch picture tube. Sliding bread pans can be seen at lower center

C-D-F SILICONES

For high temperature electrical insulation



1. COIL MOUNTING — GB-112S. Machined by C-D-F; sawed to shape, holes drilled, slot end-milled, large holes fly cut, characters stamped.

2. AIRCRAFT TERMINAL BOARD — GB-112S. Customer fabricated.

3. SHEET WASHER — GB-112S. Punched out, characters stamped.

4. COIL HOLDER — GB-112S. Cut from sheet stock, then sawed to shape, drilled in jig, slot end-milled. Work done by C-D-F.

5. SILICONE VARNISHED FIBERGLAS TAPE made in uniform thickness, in a wide range of widths.

C-D-F SILICONE TAPES are recommended for Class H insulation. It's been proved that silicone insulation has 10 times longer life than Class B insulation, even at the temperature limits of Class H. There are two types of C-D-F Silicone Tapes and Sheets: (1) Silicone varnished fiberglas; (2) Silicone rubber fiberglas. Each has the following properties:

- High temperature resistance
- High dielectric strength
- Low dielectric loss
- Resistance to moisture
- High tensile strength
- Flexibility

Both grades meet A.I.E.E. Standard for Class H insulation. They resist mild alkalis, non-oxidizing acids, mineral oils, oxygenated solvents. Silicone rubber fiberglas is recommended for many applications requiring a flexible abrasion-resistant material with good thermal conductivity. C-D-F Silicone tapes and sheets are available in a wide range of sizes in continuous rolls. For complete details, write for Technical Bulletin #47.

C-D-F SILICONE DILECTO LAMINATED PLASTIC

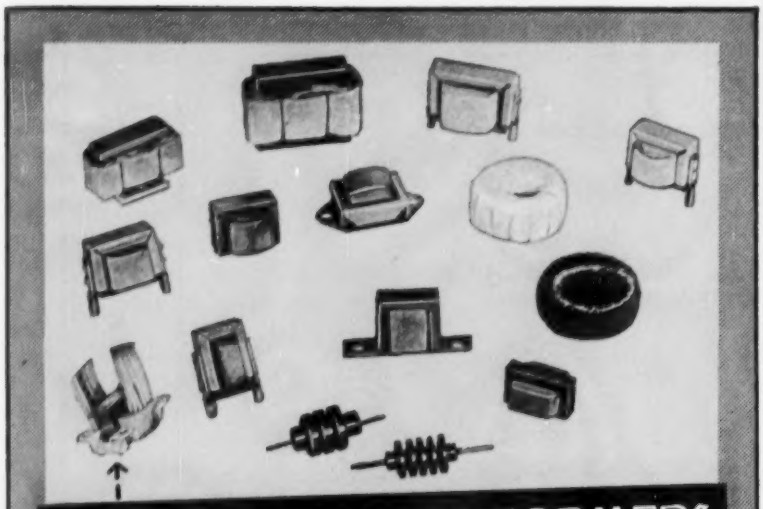
Many of the parts illustrated were manufactured and fabricated by C-D-F . . . who has a wealth of experience, forward-looking engineering and modern facilities that can be put to work for you. C-D-F is a dependable source of supply for insulating materials, and is noted for its fair pricing, for producing high quality products on schedule. Why not call in a C-D-F sales engineer on your problem. Or, write for Technical Bulletins:

#25—complete data on GB-261S, a fiberglas silicone laminate made of a staple filament woven fiberglas cloth and silicone resin in sheet form; #37—covers glass base silicone metal clad laminates; #42—post-forming grade of glass base silicone in sheet form; #23—GB-112S, fine weave continuous filament woven fiberglas with silicone resin, sheets, tubes, rods, molded shapes.

See our general catalog in Sweet's Design File for more data, the address and telephone number of your nearest C-D-F sales engineer. Also, write for technical bulletin and specific catalog, free test samples, or send us your print for quotation.

Continental-Diamond Fibre

CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.
NEWARK 16, DELAWARE



ADVANCED TRANSFORMERS AND MAGNETIC AMPLIFIERS

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One of Celco's "advanced" miniatures compared to an ordinary lead pencil.

"Advanced" means the smallest, most modern and most efficient miniature components it is possible to make today . . . built to the most precise, demanding specifications of the electronics industry.

BETTER PERFORMANCE WITH LESS WEIGHT AND SPACE

1. Thin-gauged, grain-oriented nickel alloys yield improved magnetic properties.
2. Glass, asbestos, silicone, and polyester film insulations allow higher operating temperatures.
3. Skilled craftsmen using miniaturization techniques highly developed and applied at Celco.

MISSILE AND AIRCRAFT
Miniaturized Components

Transformers
- Chokes
- Matching
- Low Level Input
- Output
- Transistor Circuits

Magnetic Amplifiers
- Demodulators
- Limiters
- Saturable Reactors
- Signal
- Pulse

Celco

Take advantage of the Celco design and production experience in this specialized field. Get a Celco estimate—improve your quality—reduce your cost.

Constantine Engineering Laboratories Co.

Island Avenue Mahwah, N. J.

self-tapping screws, to serve as outrigger supports for the wider picture tube. These wings necessitate having 2 inches more space between chassis units on the moving belt. The required space is achieved automatically by running one belt conveyor faster than the other.

On the first conveyor belt, chassis units touch each other while upside down for insertion and soldering of under-chassis parts. At the end of this conveyor, an operator turns the chassis over in its steel pallet and moves it around the bend, for loading onto a similar belt conveyor running back down the other side of the long line. When 24-inch sets are going through, this second conveyor is speeded up just enough to get the required 2 inches of extra space for the wings.

A metal trough running down the entire length of the line on each side, in front of the operators, serves as a support for standard bread pans used for holding parts. These can readily be slid along the line, changed or removed as needed for production requirements. This trough arrangement has proved simpler and superior to a former arrangement wherein brackets riveted to the pans were slid along a steel strap bolted to the front of the line.

Building Potted Amplifiers

SECTIONS of airborne electronic equipment are assembled on small cards suitable for embedment in epoxy resin to form plug-in units, in the Broad Brook, Connecticut plant of Hamilton Standard.

During assembly and soldering,

Holding fixture for cards. Two-electrode resistance soldering iron is being used for assembly. Either holding plate can be pushed back against spring pressure for removing card

Puts your business on a cash basis

If you are an electronics manufacturer or a wholesaler with annual or potential sales of $1,000,000 or more you can profitably use our kind of banking service to provide increased working capital without increased indebtedness or dilution of profits.

Why not investigate this modern approach to your money problems and learn how you can put your business on an all-cash basis, with wider opportunities for sales and profits.

More than four hundred companies in various industries are now profitably using our banking services.

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Providing operational financing for manufacturers and distributors of furniture, apparel, electronics, plastics and textiles.

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HYSOL 6000
goes to sea with RAYTHEON RADAR

The S. S. Lurline, one of the largest U. S. passenger liners, is the first big ship in the world to install Raytheon's new Model 1500 small boat radar. Scheduled for use as "standby" equipment, it will be used in conjunction with the regular 16-inch big ship "Mariners' Pathfinder" radar, shown in foreground and demonstrating comparative size. Chief Officer R. McKenzie inspects scope reading of the Model 1500.

HYSOL 6000 Epoxide Resins Used in Component Parts . . .

Complicated internal component parts of Raytheon radar equipment are formulated from HYSOL 6000 Series epoxide compounds because of their outstanding electrical and mechanical properties. In addition, HYSOL 6000 Series compounds provide a material which is economically molded into intricate shapes, including complicated inserts.

HYSOL 6000 Series compounds are made from the new epoxide resins and include a complete selection of room temperature and heat curing potting and casting compounds, easily machined sheets, rods and tubes, and coating and laminating varnishes.

The Raytheon application of HYSOL 6000 may suggest to you other plastic uses now posing a problem in your design or production departments. Houghton Laboratories, Inc., is ready to assist you with these problems through the experienced services of our skilled research laboratory, design and production departments. Your investigation will be welcomed at no obligation. Write, wire or phone today!

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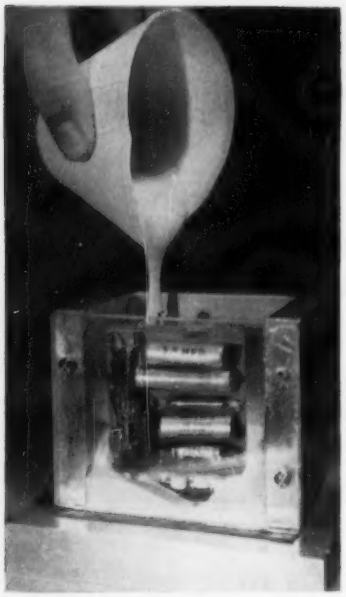
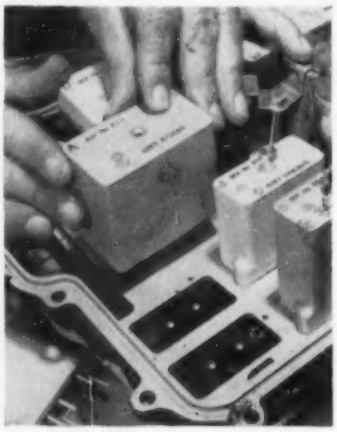
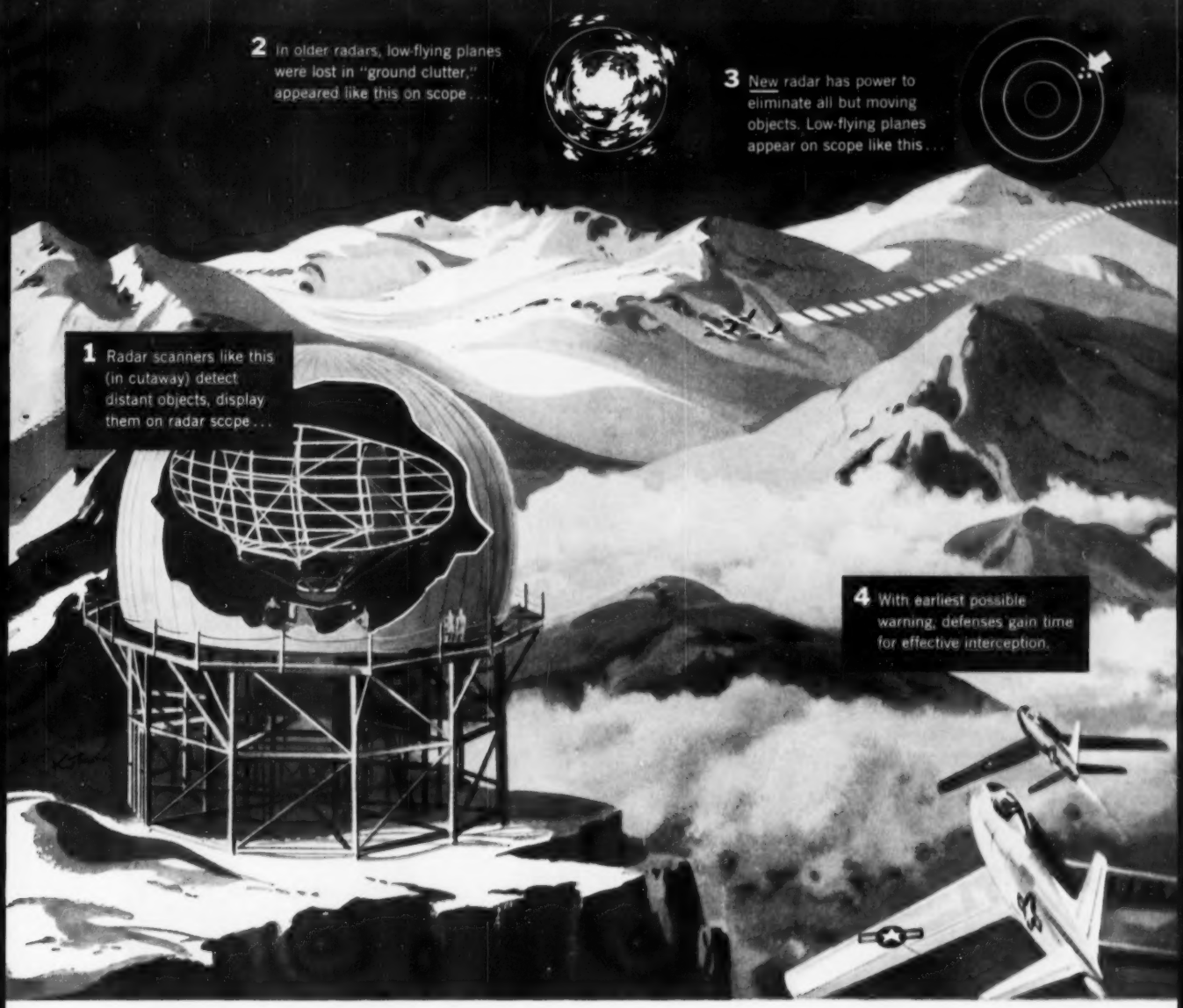


Cutaway mold with plastic window shows pouring operation

each card is held between spring-loaded metal plates and positioning pins, these guide the operator in keeping parts within space limits so they will not be too near the outer surface after embedment in the plastic. The positioning and holding plates are made up as U-shaped pieces sliding on a metal rod under spring loading. The threaded ends of the rod are bent at right angles and welded to a metal plate serving as a base for the fixture. The positioning pins have pedestals for holding the cards off the base, since parts are mounted on both



Plugging finished unit into chassis of fuel control unit which will calculate almost without time lag the exact amount of fuel left in all tanks of a plane


2 In older radars, low-flying planes were lost in "ground clutter," appeared like this on scope . . .
3 New radar has power to eliminate all but moving objects. Low-flying planes appear on scope like this . . .
1 Radar scanners like this (in cutaway) detect distant objects, display them on radar scope . . .
4 With earliest possible warning, defenses gain time for effective interception.

NEW POWER SOURCE TIGHTENS RADAR DEFENSES

Million-Watt Klystrons Aid Detection of Distant, Low-Flying Planes

THE STORY BEHIND THE STORY:

What is the significance of the headline above? To borrow from an old baseball expression, *"You can't hit 'em if you can't see 'em"*— approaching planes that formerly evaded radar detection can now be "seen" at greater distances than ever before.

■ Behind this improved radar vision is a new family of high power tubes known as Megawatt Klystrons. These new tubes not only provide greater ability for beaming radar impulses against small and distant objects but provide a new improvement to a technique known as M.T.I. or Moving Target Indication. In radars without M.T.I. everything within the beam of the radar appears on the viewing scope. Images from trees, terrain, buildings, all combine to form "ground clutter" on the scope. M.T.I. eliminates this "ground clutter" by indicating moving objects only. Therefore with Megawatt Klystrons, approaching aircraft can be spotted sooner and defenses can be alerted more quickly.

■ Producing millions of watts of electronic power, these giant tubes make possible illumination of small objects with radar impulses at greater distances to provide clear, sharp images on the radar scope. Furthermore, the Megawatt Klystron's stable performance and long life assure that these radar sentries are constantly on guard.

■ The Klystron tube made microwave radar possible. Developed by Sperry, it generates, amplifies or multiplies microwaves. Today, Sperry produces Klystrons covering a wide range of powers and frequencies for specific requirements — both military and industrial. To meet demands for these tubes, a new plant has just been opened devoted exclusively to Klystron research and production.

SPERRY GYROSCOPE COMPANY
Great Neck, New York
DIVISION OF SPERRY RAND CORPORATION

INDUSTRIAL POCKETSCOPE

by Waterman

MODEL S-11-A

DC-COUPLED WORK-HORSE OF INDUSTRY

Size:
11" x 5" x 7"
8¾ Pounds

ANOTHER EXAMPLE OF Waterman PIONEERING...

The INDUSTRIAL POCKETSCOPE, model S-11-A, has become America's most popular DC coupled oscilloscope because of its small size, light weight, and unique flexibility. This compact instrument has identical vertical and horizontal amplifiers which permit the observation of low frequency repetitive phenomena, while simultaneously eliminating undesirable trace bounce. Each amplifier sensitivity is 0.1 Volt rms/inch. The frequency responses are likewise identical, within —2 db from DC to 200 KC. Their total undistorted outputs permit effective trace expansion of twice the screen diameter. The internal sweep generator is continuously variable from 3 cycles to 50 KC and can be synchronized from positive going signals. Return trace blanking is optional. Intensity modulation is accomplished by connecting either directly to the grid of the three-inch cathode ray tube or thru an amplifier having a gain of approximately 10 and a flat response to 500 KC. Direct intensity modulation threshold voltage is approximately 1 volt rms. Additional provisions for direct access to all the deflection plates, the second anode, and the amplifier output terminals extend the usefulness of the S-11-A many fold.

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S-11-A INDUSTRIAL POCKETSCOPE®
S-12-B JANized RAKSCOPE®
S-14-A HIGH GAIN POCKETSCOPE
S-14-B WIDE BAND POCKETSCOPE
S-15-A TWIN TUBE POCKETSCOPE
RAYONIC® Cathode Ray Tubes
and Other Associated Equipment

sides of the card.

For embedment, the finished card is plugged in to a metal mold and the resin is poured in from a paper cup. The bottom of the mold has holes for the plug-in terminals; these serve to center the card in the mold, hold it at the correct height above the base of the mold and keep the resin away from the terminals.

The finished unit is trimmed, polished and appropriately imprinted, after which it can be plugged directly into sockets on the chassis of the electronic fuel control unit or other control for which it was designed.

Pump Feeds Cement to Both Sides of Mold

A NEW dual-nozzle metering pump for hot or cold cements, sealing waxes and other viscous materials makes it possible to pour approximately equal quantities simultaneously into opposite sides of a mold or cavity. This technique is desirable when it is not practical to pour into the center of the cavity, either because there is an obstruction or restricted area in the center, or the cavity is relatively shallow and the material would chill before spreading completely, or overflow the sides if poured in a single mass.

Setup for applying molten sealing wax simultaneously to both sides of lightning arresters for radio and television antennas

The dual-nozzle pump is being used by JFD to apply molten seal-

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CLASS H
TUBING and SLEEVING

for applications requiring prolonged heat endurance at temperatures up to 260°C.

Varglas Silicone tubing and sleeving were developed by Varflex for applications involving continuous operating temperatures up to 260° C. Exceptional stability is combined with the following qualities . . .

Flexibility — sharp turns and 90° bends cause no cracking or peeling — no loss of dielectric strength.

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Flame-Resistant — Standard burning test is 45 seconds to burn 1 inch. Can be made self-extinguishing on special order.

Cold-Resistant — Excellent resistance to chafing and abrasion, flexible to —35°C.*

**For temperatures down to —65°C, and for applications requiring extraordinary flexibility, we recommend our new Varglas Silicone Rubber sleeving and tubing. Inquiries invited.*

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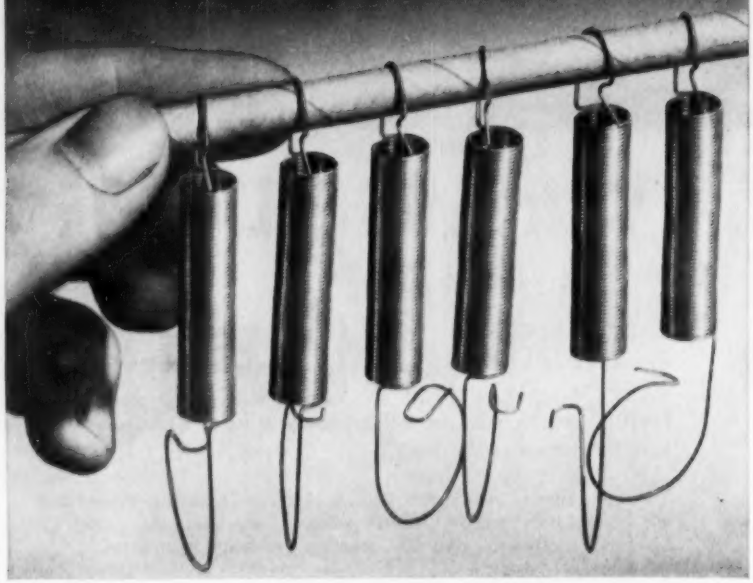

● There is an "extra" Lewis Service many spring users don't know about . . . it might be called: "packing for production" or "arranged for automation." It's simply the way in which Lewis Springs and Wireforms may be shipped to reach the production line ready for quick, time-saving handling and the most efficient assembly operation . . . by hand or automatic equipment.

Working with customer's production men, Lewis Engineers devise the packing method best suited to the job: Perhaps threaded on a rod . . . on special holders . . . in envelopes . . . tied or grouped in bundles . . . and in many other different ways.

If you use springs and wireforms, and have plans to further "automate" production we'd like to help you with our "extras" in Lewis Service. And, of course, top quality springs and wireforms are our business. Send us your problem.

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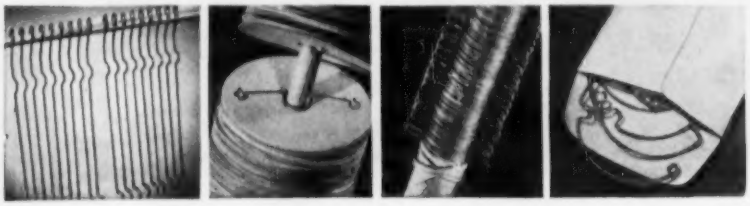
Lewis PRECISION SPRINGS

The Finest Light Springs and Wireforms of Every Type and Material



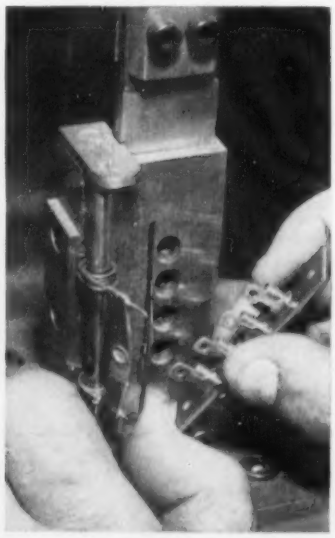
ing wax to lightning arresters. Pouring on both sides of the cavity and central screw in a single operation, instead of the two formerly required, has resulted in a 50-percent saving in labor and a maked reduction in the number of rejects. The operation can now be handled by a nonskilled operator.

The new pump, manufactured by Edward E. Robinson. Inc., Nutley, N. J., has a solenoid control operated by a foot switch, leaving both hands of the operator free for more efficient production. It has thermostatically controlled electrical heating up to 450 F., a no-drip check nozzle and a quantity selector affording instantaneous adjustment to any one of twenty proportional quantity positions. With automatic feeding of parts, up to 6,000 units per hour can be processed.

Thread-Mutilating Tool

THE END threads of four screws on a terminal strip are simultaneously mutilated by a simple air cylinder setup in Emerson's Jersey City plant. This prevents the screws from falling out due to vibration during shipment of television receivers on which this strip serves for connecting internal and outdoor antenna leads.

The operation involves pulling back a mousetrap-type spring and



Method of loading terminal strip in holes of die while holding back spring clip with left hand

New, convenient, compact

High accuracy expanded scale

Ideal for industrial use

-hp- 500B FREQUENCY METER—$285.00

Here's a list of the many industrial and laboratory jobs the new -hp- 500B Frequency Meter can do for you quickly, easily and without elaborate setup:

Count sine waves, square waves and pulses. Indicate average frequency of random events. Measure beat frequency between rf signals. Determine oscillator stability. Measure crystal frequency deviation. Measure temperature, pressure, weight and other physical quantities which can be converted to frequency.

This versatile instrument also serves as a convenient automatic motor speed control, overspeed and underspeed control and makes possible a permanent record of frequency or speed as a function of time. And, it may be used for automatic control of quartz crystal etching.

-hp- 500B covers the range 1 cps to 100 KC and provides direct readings of high accuracy. Readings are not affected by either signal or line voltage variations. An expanded scale permits any 10% or 30% segment to be viewed over the full meter range, making possible highly accurate measurements of differential frequency. A pulse output is provided to sync a stroboscope and continuous recordings of readings may be made on an Esterline-Angus recorder.

Model 500B is extremely compact, light, easy to use and of quality construction throughout. It is also available as Model 500C, calibrated in RPM.

BRIEF SPECIFICATIONS

Freqency Range:	1 cps to 100 KC. 9 ranges.
Input Voltage:	0.2 v sensitivity (sine waves) 1.0 v min. (pulses) 250 v peak max.
Input Impedance:	Approx. 1 megohm shunted by 40 $\mu\mu$f.
Accuracy:	Better than ± 2% full scale.
Self Check:	Convenient calibration based on line voltage frequency.
Recorder Output:	Panel jack for 1 ma, 1,400 ohm Esterline-Angus Automatic Recorder.
Pulse Output:	To trigger strobe, etc., in sync. with input.
Photocell Input:	Panel jack with bias for 1P41 phototube, 40 $\mu\mu$f shunt.
Power:	115/230 v ± 10%, 50/1,000 cps, 110 watts.
Size:	7⅜" x 11½" x 12¼". Wt. 17 lbs.
Price:	-hp- 500B or 500C: $285.00.

Data subject to change without notice. Prices f. o. b. factory.

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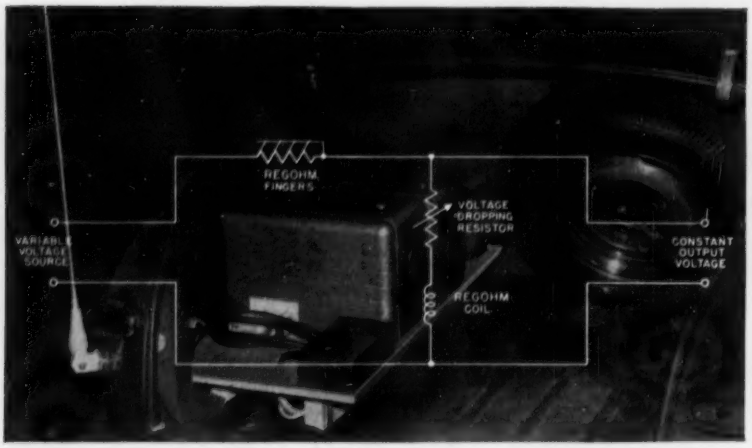


Extend Vacuum Tube Life *and reduce maintenance with Regohm DC Filament Voltage Regulation*

Successful field tests by engineers of one of the leading communications systems led to their using REGOHM to regulate filament voltage and prolong vacuum tube life in mobile telephone systems. You will find it profitable to do the same with your vacuum tube system. Rugged and compact, with long service life, REGOHM's low cost is quickly returned by longer trouble-free tube life and reduced service costs. *And* REGOHM requires no maintenance.

When filaments are operated above rated voltage, trouble follows. A filament operating at 10% above rated voltage operates on borrowed time. Its life is only one-third as long as it might be with constant voltage. The same life or death statistics apply to other type filaments; with coated filaments, the electron-emitting material may be boiled off and deposited on other tube elements and affect performance.

Variable power-source voltage can be held to a constant by using REGOHM in the type system shown in the schematic. The REGOHM signal coil directly senses filament voltage while finger contacts automatically insert resistance in series with the input line, maintaining a constant voltage.

With Regohm you get these advantages:

Sensitivity: Filament-voltage maintained within a 4% band for all values of input voltage higher than the regulated voltage plus the minimum REGOHM resistor drop. Better regulation at higher voltages possible by using signal amplifying scheme.

Wide Range of Control Resistance: From zero to infinity within limits determined by the contact ratings. When load currents are less than five amperes, minimum resistance approaches zero, enabling REGOHM to control output voltage at a value only slightly higher than minimum input voltage.

Stability: No anti-hunt network required. Built-in adjustable dashpot insures stability without sacrificing sensitivity or speed of response.

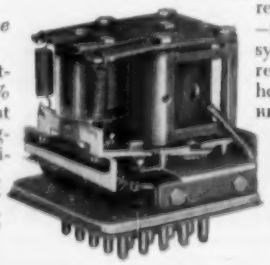
Long Life: At loading of eight watts per step, many thousand hours life can be expected. Infinite life at very low loadings.

Wide Voltage Range: Output voltages from one to 500 volts can be controlled.

Maintenance Free: No maintenance. Replacement simplified by plug-in design. All units interchangeable.

Permanent Adjustment: REGOHM maintains its characteristics after long periods of operation or storage.

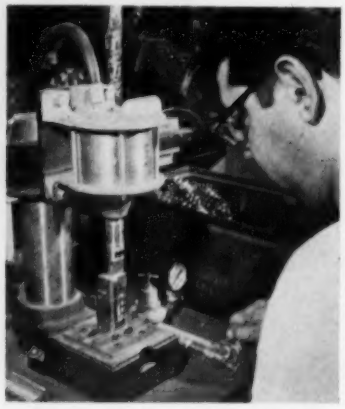
Rugged Design: Meets the most rigid commercial and military specifications. Hermetically sealed units available for operation at high altitudes or in corrosive atmospheres. Shock and vibration proof.



An extensive field engineering force is ready to assist you—at no cost—in applying REGOHM to your system. They will calculate required resistor networks, help you choose the proper REGOHM type, engineer special circuiting if needed. Write, wire or phone Electric Regulator Corporation, 100 Pearl Street, Norwalk, Conn. Applications will receive prompt attention.

REGOHM

CONTROL COMPONENT IN: Servo systems • battery chargers • airborne controls • portable and stationary generators • marine radar • inverters • locomotive braking systems • mobile telephones • guided missiles • signal and alarm systems • telephone central station equipment • magnetic clutches • railroad communication systems • magnetic amplifiers.



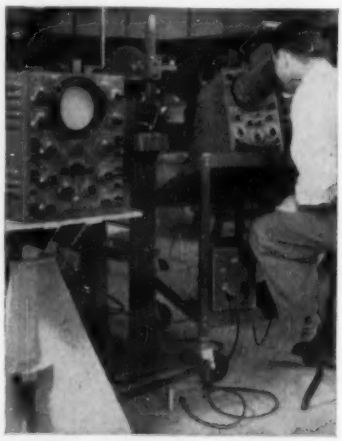
Operating air valve to bring down die-plate that mutilates threads of all four terminal screws at their ends simultaneously

inserting a terminal strip. The terminal screws go into four drilled holes and the terminal lugs go into a single vertical slot. The spring is released to hold the strip in place. The operator then pushes the air valve to operate the cylinder. This brings down a die-plate having four drilled holes, so arranged that the die mashes only the outer two threads of each screw on their upper sides when the die is down.

Drop Test for Instruments

By SETH T. MCCORMICK
Technical Products Division
Allen B. Du Mont Lab., Inc.
Clifton, New Jersey

THE DIFFERENTIAL transformer is used to determine the displacement, velocity and acceleration of an in-



Setup for drop-testing finished oscilloscope, on table of hydraulic lift at left. Operator views waveform of impact signal produced by differential transformer in brass cylinder on floor

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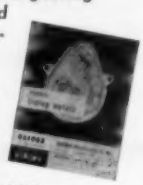

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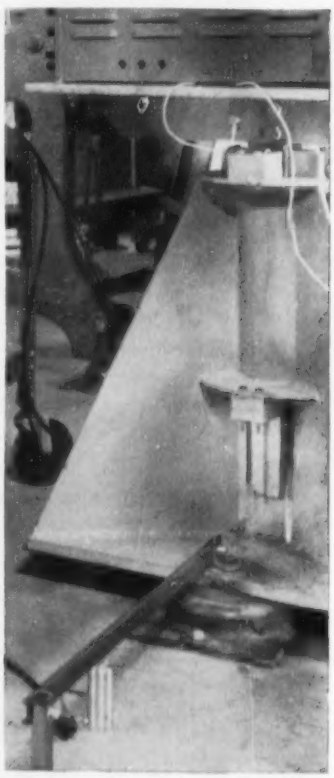
** Trade Mark Reg. U.S. Patent Office*

strument on a drop table. The instrument to be drop-tested is fastened on the top of the table and the whole assemblage is lifted hydraulically a short distance and dropped. Impact is controlled by heavy industrial shock mounts under the table.

To bring the displacement of the table within the range of measurement of the differential transformer, a lever arm is fastened to the base of the drop table and pivoted at a point about 3 feet away. The differential-transformer core is attached to the lever a short distance from the pivot point with the differential transformer itself mounted in a heavy piece of brass rod positioned directly underneath.

The output of the differential transformer is applied to a Du Mont type 332 differential-transformer control, where the signal information is removed and in turn applied to the input of a Du Mont type 324 cathode-ray oscillograph where it is photographically recorded by a type



Lever arm is pivoted to floor in foreground with far end bolted to base of shock-mounted table. Differential transformer core, in cylinder, is attached to lever near pivot

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All inclusive! That distinguishes the Aerovox automation program from all others. Not limited to any one phase, we are dealing with mechanical, material, electronic, electrical, production and economic aspects for **across-the-board** automation.

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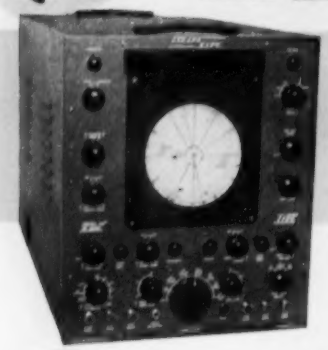
10 functions in 1



COLORSCOPE
VIDEO SIGNAL EVALUATOR

MONOCHROME AND COLOR

In this one multi-function instrument, a complete tool for analysis of every characteristic of the video signal. COLORSCOPE is a major advance in TV instrumentation, combining the advantages of multiple functions with a high standard of operating precision. Write for specifications.

Versatile!

10 displays can be switched in sequence on the CRT face: picture monitor . . pulse cross monitor . . two lines horizontal time . . two fields vertical time . . NTSC vectorscope . . external vertical signal at horizontal or vertical time . . external horizontal or vertical amp . . phase demodulator scope . . quadrature phase demodulator scope. 14" x 16" x 23" plus power supply, mobile or rack mounted.

TARC ELECTRONICS

TARC ELECTRONICS INC.
49 URBAN AVENUE • WESTBURY, N. Y.

"HOW MEYERCORD SERVES INDUSTRY"
No. 5 of a Series

MEYERCORD *Nameplate* DECALS Help You KEEP Your Product SOLD

Meyercord Decals solve the dealer identification and service problem effectively with a time-tested, low cost "factory-dealer" nameplate plan which combines your trademark with the name, address, and phone number of your local authorized dealer. Although ordered by the manufacturer, Meyercord Dealer Decal Nameplates need cost the manufacturer nothing. Specially imprinted Decal Nameplates are sold to and applied by your dealers, who actually save 80% of what similar decals would cost if purchased independently.

We create, design, develop and produce factory-dealer decals in any combination of colors, shape, size, and artwork, in any quantity. Dealers order small quantities from your company as needed. Meyercord then "personalizes" each dealer order and drop-ships directly to him. Let a Meyercord representative provide details and specific recommendations.

FREE! "Mark-It" Manual of Decal Nameplates

Send today, on your company letterhead, for this valuable full-color guide to every industrial problem in marking, identification, instruction and information. Gives you hundreds of new ideas for the application of decals to your products.

THE MEYERCORD CO.
World's Largest Decalcomania Manufacturers

Dept H-303
5323 WEST LAKE ST.
CHICAGO 44, ILLINOIS

297 Polaroid-Land oscillographic recording camera.

By successive differentiations of the displacement signal, velocity and acceleration may be obtained. Of interest in the test is the impact in G's on the instrument. We broke several accelerometers in an attempt to use the more direct method of deducing acceleration.

Installing Mounting Clips for I-F Transformers

A SIMPLE rocking tool mounted on a screw-driver shaft is used in Emerson's Jersey City plant to push down the special spring steel clips that are used for mounting an i-f transformer on a metal panel. The operator inserts the transformer in punched holes from underneath, by

Method of using tool to lock spring clips after inserting transformer in metal I-f panel from underneath through opening in frame of Emerson pass-along line

reaching through an opening in the wood support for the metal-rail pass-along rail. At this position, a metal plate on the upper rail and an additional angle-iron strip on the lower rail hold the panel in position so that the operator can push up against it while inserting the transformer. The clip is then halfpushed into position between the transformer terminals on the other side of the chassis, so that one end goes through the chassis

"BEST IRON WE'VE HAD in the plant," says William Fish, a production supervisor of General Radio. This company recently switched to G-E Midget irons for soldering *both* delicate and heavy joints in their Type 1862-B Megohmmeters—jobs which formerly required *both* a heavy and a light iron. In addition, the G-E Midget iron's light weight has helped reduce operator fatigue.

50 G-E Midget irons do work of 100 former irons at General Radio Co., boost production 25%

HANDLES LIKE A PENCIL—Weighing less than a package of cigarettes, the General Electric Midget soldering iron speeds production by reducing operator fatigue.

RAPID HEAT TRANSFER is achieved through a famous Calrod* heater located in the ironclad-copper tip. Result—the G-E Midget iron's heat efficiency is 90%.

*Reg. trademark of the General Electric Company

THREE-IN-ONE IRON with 1/8", 1/4", 3/16" tip sizes gives you greater versatility to meet your soldering requirements. Tips can be changed in only 5 seconds.

For more information write for GED-2263, G-E Midget Soldering Iron, Section 724-3, General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC

as small as the tube it cools...

ACTUAL SIZE

EAD's subminiature CENTRIFUGAL BLOWER

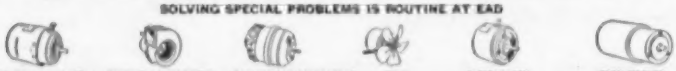
Here is the most compact centrifugal blower unit made . . . EAD's high-velocity subminiature centrifugal blower is only 2⅞" long, weighs only 6 ounces, yet it can move 13 cfm of air at a velocity of 3,000 feet per minute—and the volume holds up at high static pressures. It is driven by EAD's new one-inch diameter motor. The metal blower housing can be rotated to any position desired for maximum efficiency in cooling radar equipment, amplifier units, transmitter equipment, oscillators, and in other applications where high temperatures in confined areas demand miniaturized blowers with the highest possible performance characteristics. EAD's subminiature blower units meet all applicable MIL specification, and low temperature rise makes them suitable for high altitude and high ambient temperature operation.

CFM	13 @ 0" SP 10 @ 1.0" SP	7 @ 0" SP 5 @ 2" SP
MAX. SP.	2.5	0.6
RPM	20,000	11,000
AMPS	0.1	0.06
WATTS	10.0	6.0
CAPACITOR Mfd/Volts	0.25/220	0.1/220
WEIGHT (OUNCES)	6	6
MODEL NO.	B2GOU-C	B2HOU-C

Modifications of standard models or completely new designs can be engineered to meet your special cooling needs. Write for complete information.

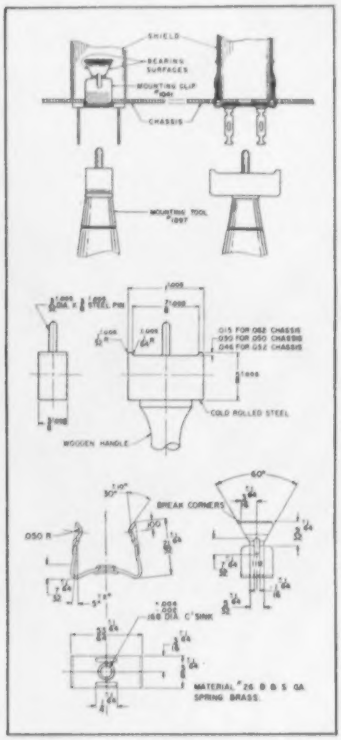
EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD



INDUCTION MOTORS · CENTRIFUGAL BLOWERS · TACHOMETER GENERATORS · FANS · ALTERNATORS · GEAR MOTORS

387 CENTRAL AVENUE • DOVER, NEW HAMPSHIRE



Details of clip and mounting tool, as recommended by Automatic Mfg. Co. for use with its K-Tran units

and snaps into the hole in the shield can. The center pin of the tool is now inserted in the center hole of the clip, and the tool is rocked to snap the other end of the clip into position.

Lacer-Insert Packaging for Boron-Carbon Resistors

METAL TRAYS holding 40 IRC deposited carbon or boron-carbon resistors are fed out through the end of an automatic assembly line to a packaging position, where a unique new cardboard package permits quick unloading of the trays without touching the resistors.

The operator first places over one half of a tray a light cardboard holder having 20 punched slots. When this cardboard holder is pressed down into the tray, the 20 resistors emerge through the slots. With her left hand the operator then pushes under the resistors a plain cardboard strip called a lacer. This anchors the resistors in the holder, since their leads project under the holder while the bodies are held above the holder by the

After initial adjustments are made, as in photograph, "Mr. Meticulous" automatically performs critical operations in making junction tetrode transistors—tiny experimental devices which may find important uses in the telephone system.

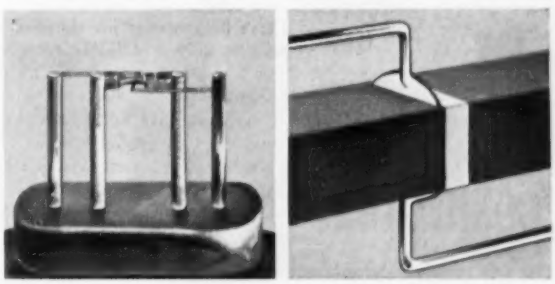
The machine we call "Mr. Meticulous"

Bell Laboratories scientists, who invented the junction transistor, have now created an automatic device which performs the intricate operations required for the laboratory production of experimental model transistors.

It takes a bar of germanium little thicker than a hair and tests its electrical characteristics. Then, in steps of 1/20,000 of an inch, it automatically moves a fine wire along the bar in search of an invisible layer of positive germanium to which the wire must be connected. This layer may be as thin as 1/10,000 of an inch!

When the machine finds the layer, it orders a surge of current which bonds the wire to the bar. Then it welds the wire's other end to a binding post. Afterward, it flips the bar over and does the same job with another wire on the opposite side!

Once only the most skilled technicians could do this work, and even their practiced hands became fatigued. This development demonstrates again how Bell Telephone Laboratories scientists work in every area of telephony to make service better.



Transistor made by new machine is shown in sketch at left above, magnified 6 times. At right is sketch of area where wires are bonded. The wires are 2/1000 inch in diameter, with ends crimped to reduce thickness.

BELL TELEPHONE LABORATORIES

IMPROVING TELEPHONE SERVICE FOR AMERICA PROVIDES CAREERS FOR CREATIVE MEN IN MECHANICAL ENGINEERING

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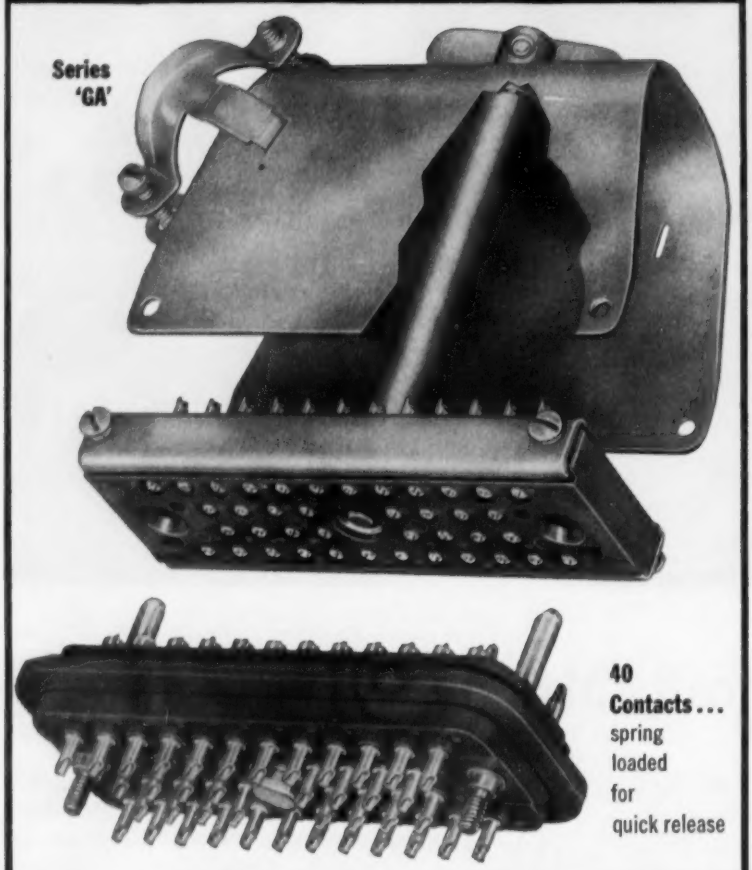
new... precision **Continental Connectors**



40 Contacts... spring loaded for quick release

Quick Release

PRESSURIZED CONNECTORS

for guided missile and similar applications

Here's the connector you can specify for pressurized equipment without fear of dangerous air leakage. The Series "GA" plug is molded from Orlon filled Diallyl Phthalate. When subjected to a pressure differential of 30 PSI at 25° C, leakage is less than 1 cubic inch of air per hour. This series is available with hood and cable clamp. Gold plated, nickel silver contacts take #16 AWG wire, and each is spring loaded for easy release. A spring action center screwlock permits quick, easy release or engagement without damage to the unit.

Write for complete technical data without obligation.

Note: Complete Continental Connector Catalog, covering subminiature, printed circuit, hermetic seal, pressurized, high voltage and power connectors, is available on request. Send us your name and title on your company letterhead.

Electronic Sales Division
DeJUR-Amsco Corporation,
45-01 Northern Boulevard, Long Island City 1, N. Y.

DeJUR

Method of inserting lacer strip to anchor precision resistors in holder of shipping carton. Each metal tray-load of resistors fills two cartons

lacer. The flaps of the holder are next folded over the resistors and locked in position. This envelope-type package is then slipped into the final cardboard shipping carton.

Resistors can be removed one at a time by pulling back the lacer strip or all can be removed at once by pulling the strip entirely out. This type of packaging is used in the Philadelphia plant of International Resistance Co.

Lead Length Gage

A GAGE that minimizes mistakes in setting up machines for cutting leads of components to desired lengths is used in Emerson's Jersey City plant. It is essentially a square piece of sheet metal having at each of its four corners a projecting rectangle, whose sides correspond in lengths to the various lead lengths commonly used. Thus, the dimensions of the rectangle at one corner are $\frac{5}{8}$" by $1\frac{1}{2}$". Another is $\frac{7}{8}$" by $\frac{3}{4}$", the third is $\frac{1}{2}$" by $1\frac{1}{4}$" and the fourth is a 1" square. The dimensions of the sides are clearly stamped in the metal.

With this gage, the operator of a cutting machine can change the setting herself, eliminating the need for calling a mechanic. She can also check the cut leads from time to time as produced by the machine, to make sure that settings have not shifted.

F.M. DEVIATION
Directly Measured

with this time-saving and accurate MARCONI instrument

If you haven't a deviation meter you can use the Bessel Zero or "Disappearing Carrier" method of measurement; this, however, required complex monitoring equipment, an accurately-known modulation frequency, and, finally, mathematical interpretation of results.

With the compact and easy-to-use Marconi Deviation Meter, the modulation frequency need not be known and deviation is directly read on a meter scale.

F.M. DEVIATION METER
TYPE TF 934/2

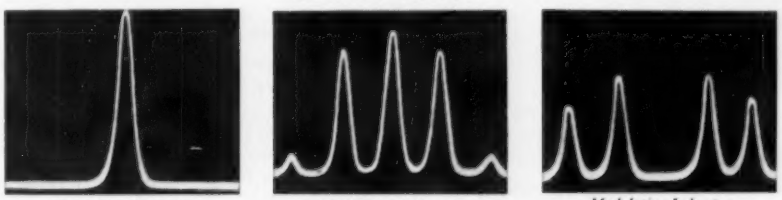
Carrier Frequency Range:
2.5 to 200 Mc.

R. F. Input Level:
55 mv to 10 v.

Deviation Measurement Ranges:
5, 25, and 75 kc full-scale.

Accuracy of Deviation Measurement:
$\pm 3\%$ from full-scale to half-scale up to 12 kc and $\pm 6\%$ up to 15 kc.

BESSEL ZERO METHOD



Unmodulated Carrier — *Modulation Index 1.3* — *Modulation Index 2.4 The Carrier "Disappears"*

MARCONI INSTRUMENTS

VACUUM TUBE VOLTMETERS · FREQUENCY STANDARDS · OUTPUT METERS · F.M. & A.M. SIGNAL GENERATORS
DEVIATION METERS · WAVEMETERS · WAVE ANALYSERS · Q METERS · BEAT FREQUENCY OSCILLATORS

Full data and prices will be mailed immediately on request.

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CANADA: CANADIAN MARCONI CO., MARCONI BUILDING, 2442 TRENTON AVENUE, MONTREAL. **ENGLAND:** Head Office: MARCONI INSTRUMENTS LTD., ST. ALBANS, HERTS.
Managing Agents in Export: MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2.

TC 40

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New Products

Edited by WILLIAM P. O'BRIEN

86 New Products and 63 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

SELENIUM RECTIFIERS
for printed circuits

FEDERAL TELEPHONE AND RADIO CO., 100 Kingsland Road, Clifton, N. J., announces a new line of selenium rectifiers for use with printed circuits. Three different types of terminals are available: (1) A square-tipped type for insertion into printed circuit boards up to $\frac{1}{16}$ in. thick. (2) A tapered type designed for maximum ease of insertion by automatic equipment in printed circuit boards up to $\frac{1}{8}$ in. thick. (3) A snap-in type which

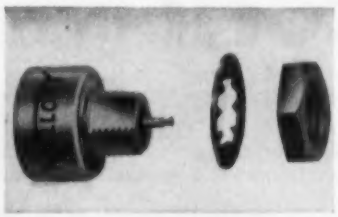
holds the rectifier firmly in place even when the circuit board is subjected to vibration or inverted prior to soldering. The printed circuit rectifier series is available in current ratings up to 150 ma for line input voltages up to 175 v a-c. The present series consists of 12 different rectifiers in $\frac{1}{16}$ in., 1 in. and $1\frac{1}{4}$ in. cell sizes, with further expansion planned. These rectifiers can be designed up to 600 ma. Among the advantages are: low assembly and soldering costs, easy insertion, elimination of sockets and adaptability to automation.

VIBRATION METER
both rugged and precise

DUBROW DEVELOPMENT CO., 235 Penn St., Burlington, N. J. Designed for convenience and maximum utility, model 381 vibration meter is a valuable tool for researchers, designers and test engineers in the various fields where mechanical vibration plays an important role. Frequency response is ±1 percent from 10 to 1,000 cps. Amplitude linearity is ±1 percent over most of the meter scale. One large indicating meter provides direct readings of both the displacement in mils and the velocity in ips. Three standard input filters provide frequency cutoff at 30, 70 or 110 cps, thus rejecting interfering l-f vibrations. The filters are plug-in components, and special types can be readily installed by the user. Selection of a particular filter or no filter at all, is accomplished with a switch on the front panel. JAN components are used extensively.

TANTALUM CAPACITOR
with integral mounting

P. R. MALLORY & CO., INC., Indianapolis, Ind. A new refinement of the XT Tantalum capacitor features a method of integral mounting that withstands heavy shock and vibration. Developed for use in guided missiles and other electronic equipment subject to severe acceleration, the capacitor has a threaded neck which fits through a keyed slot in the chassis. A lock washer and hex nut, supplied with the capacitor, hold the unit securely in place.



Straps or other hardware are not necessary. The capacitor operates at ambient temperatures from −55 C to +175 C, and can be supplied for use at 200 C. A wide selection of ratings is available.

PENTODE TUBE
for television receivers

RADIO CORP. OF AMERICA, Harrison, N. J., has added to its line a sharp-

Redesigned

to solve your horizontal deflection problems

CIRCUIT DESIGNED
OK
CIRCUIT TESTED

—these Sylvania deflection amplifier tubes offer higher plate currents, greater dissipation

Here is a full line of Sylvania Tubes—made to take the tighter conditions of horizontal deflection circuits in streamlined TV chassis designs.

New plate and grid designs achieve minimum zero bias plate to screen grid current ratios of 10 to 1. Plate dissipation has been increased to provide more stable performance throughout tube life. Designed to exhibit low plate knee characteristics, these tubes eliminate "snivet" problems when operated properly within ratings.

Whatever the nature of your TV design problem, Sylvania Tubes are "circuit-designed and circuit-tested" to meet your needs.

Deflection Types for Transformer Circuits

6BQ6GTA 6CD6GA
6CU6 6DQ6

Deflection Types for Series—String circuits

12BQ6GTA 12CU6
25BQ6GTA 25CD6GA
12DQ6

SYLVANIA®

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Building, Montreal

SYLVANIA ELECTRIC PRODUCTS INC.
Dept. 120P, 1740 Broadway, New York 19, N. Y.

☐ Please send complete data on "circuit-designed and circuit-tested" deflection amplifier types.

Check other tube interests.

☐ Other entertainment types ☐ Control equipment types
☐ Military types ☐ Test equipment types
☐ Special-Purpose types ☐ _____ types

Name _____

Address _____

City _____ Zone _____ State _____

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cutoff pentode designed especially for use in the gain-controlled picture i-f stages of tv receivers utilizing an i-f in the order of 40 mc, and suited also as an r-f amplifier in vhf tv tuners. The 6DE6, a 7-pin miniature type, features a controlled grid No. 1 voltage of −5.5 v for a transconductance of 600 μmhos minimum. This cutoff characteristic permits the elimination of the age amplifier in certain tv receiver designs and minimizes overload distortion and cross modulation effects in the i-f stages. In addition, the 6DE6 has high transconductance combined with low capacitance values which contribute to high gain per stage.

TRANSFORMERS

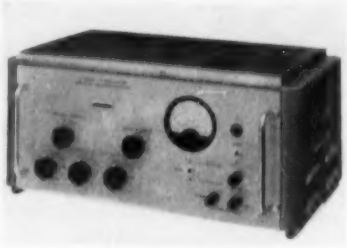
up to 35kv rms

POWER TRANSFORMER CO., INC., 532 Mulberry St., Newark 5, N. J. Through the use of a special compound with high dielectric characteristics, transformers up to 35 kv rms are built fully encased. Since no liquids are used, no leaks are anticipated. These transformers deliver up to 100 kv d-c at 9 ma in a voltage doubler circuit, or 10 kv d-c at 30 ma in a full-wave bridge, or 15 kv d-c at 20 ma in a half-wave circuit, continuous duty. To insure minimum space for the power supply, the plate and h-v filament transformers are encased in the same can. Plate and filament outputs leads are h-v polyethylene molded, capable of withstanding twice the rated voltage. Applications include electrical precipitation, cable and h-v testing apparatus and as component of h-v power supplies.

L-F OSCILLATOR

is a 2-phase unit

THE SOLARTRON ELECTRONIC GROUP LTD., Thames Ditton, Surrey, England, has available an amplitude stabilized R-C phase-shift oscillator giving a complete range on decade switching of 0.1 cycle to 1.11 kc. With a low d-c and harmonic content, the instrument will prove extremely useful where spot frequencies are repeatedly required to be set up. Type B0567 oscillator has particular use in the testing of servo systems, also for l-f vibration energization in conjunction with a suitable amplifier. The reference and quadrature outputs are isolated by cathode-follower stages, giving up to 10 v rms with respect to ground from each of the output terminals. Monitoring of output level is kept on a 3½-in. meter, which can be switched out when the maximum output is required.



TERMINALS

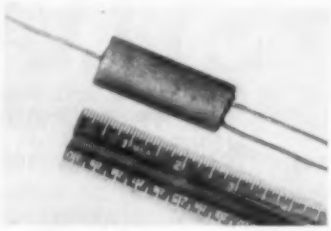
accommodate AMP taper pins

GARDE MFG. CO., 588 Eddy St., Providence 3, R. I., has available miniature and subminiature insulated standoff terminals for h-f applications and miniaturized equipment. They are supplied with taper pin connectors to accommodate AMP taper pins for solderless connections. The taper pins are also available on the company's feedthrough terminals, headers, connectors, terminal boards and other components. Body materials of the stand-off terminals are designed to meet requirements of MIL-P-14D specifications. Studs are cadmium plated to QQ-P-416 specifications.

POWER SUPPLY

provides bias voltage

MARINE ELECTRIC CORP., 600 Fourth Ave., Brooklyn, N. Y. The RB20 miniature regulated power supply is intended primarily as a source of bias voltage and is completely encapsulated in a cast plastic cylinder 2½ in. long × 1 in. in diameter with three wire leads coming out at the ends. Besides the obvious function of applying bias voltage to a high impedance potentiometer, the unit is especially adapted for plate-to-grid coupling in amplifiers. By connecting the input lead to B+, the common lead to the plate of one



ELECTRO TEC SLIP RING ASSEMBLIES

HIGH TEMP PLASTIC!

NEW ETC-7 (POLYESTER RESIN) USED ON ILLUSTRATED PART FOR HIGH TEMPERATURE OPERATION

—for high temp applications!

HARD GOLD RINGS!

24 KT. SOLID GOLD RINGS— ENTIRE RING THICKNESS ELECTRODEPOSITED UNIFORM HARDNESS, 90 to 100 BRINELL.*

COURTESY LEAR, INC.
— these two features were incorporated in the assembly illustrated above, having 45 rings, dia. .180", ring width .020", barrier width .010". Overall length, less leads 1.763".

Electro Tec Corp., in its constant endeavor to keep pace with the most exacting requirements, has developed these new processes and products. They provide flawless performance under conditions far exceeding the capabilities of other types of construction. Where high temperature is involved, the superiority of these assemblies is so marked, that acceptance has been industry-wide. At the same time, an increasing number of users are specifying these assemblies for the ultimate in dependability under normal operating conditions. Inquiries will receive prompt attention; no obligation.

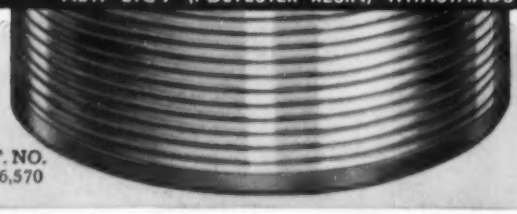
← 72 rings on integral support — no accumulated tolerances — fulfills electrical, minimum weight and space requirements.

Dual purpose assembly combining "V" grooved signal circuits and wide power rings.

Miniature high speed sampling switch — 24 channels.

Combining low friction torque slip rings (.060 dia.) with reference switch segments.

NEW ETC-7 (POLYESTER RESIN) WITHSTANDS TEMPERATURE RANGE FROM —60° to +500°F.



*PAT. NO. 2,696,570

PRODUCTS OF PRECISION CRAFTSMANSHIP BY A NEW AND REVOLUTIONARY PROCESS

ELECTRO TEC CORP.

SOUTH HACKENSACK, NEW JERSEY

MISSILE SYSTEMS

Research and Development

Broad interests and exceptional abilities are required of scientists participating in the technology of guided missiles. Physicists and engineers at Lockheed Missile Systems Division are pursuing advanced work in virtually every scientific field.

• • •

Below: Missile Systems scientists and engineers discuss future scientific exploration on an advanced systems concept with Vice President and General Manager Elwood R. Quesada. From left to right: Dr. Eric Durand, nuclear physicist, systems research laboratory; Ralph H. Miner (standing), staff division engineer; Dr. Montgomery H. Johnson, director, nuclear research laboratory; Elwood R. Quesada; Dr. Louis N. Ridenour (standing), director, program development; Willis M. Hawkins (standing), chief engineer; Dr. Joseph V. Charyk (standing), director, physics and chemistry research laboratory; Dr. Ernst H. Krause, director, research laboratories.

• • •

Scientific advances are creating new areas of interest for those capable of significant contribution to the technology of guided missiles.

Lockheed **MISSILE SYSTEMS DIVISION**

research and engineering staff

LOCKHEED AIRCRAFT CORPORATION • **VAN NUYS, CALIF.**

NATIONAL
ELECTRONICS
CONFERENCE

Chicago, Oct. 3-5

FALL MEETING
AMERICAN
INSTITUTE
OF
ELECTRICAL
ENGINEERS

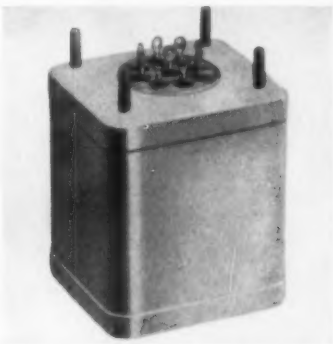
Chicago, Oct. 3-7

C.T. Petrie, A.A. Daush and senior members of the technical staff will be available for consultation at the Sherman Hotel, FRanklin 2-2100.

Lockheed

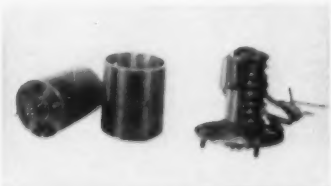
MISSILE SYSTEMS DIVISION

tube and the output lead to the grid of the following stage, the RB20 will act as a coupling battery. Another unusual feature is its ability to utilize an alternating or direct voltage power source. Designed to be directly wired into electronic circuits, the RB20 features such rugged characteristics as a zero to 200 F temperature range; immunity to humidity, condensation and other environmental conditions; also an input resistance of greater than 6 megohms; and an output voltage of 20 v negative to common at 10 megohm load.



MAGNETIC AMPLIFIERS with 2,000,000 power gain

HYCOR CO., INC., 11423 Vanowen St., North Hollywood, Calif., has available a new standard catalog series of magnetic amplifiers. Type 402, illustrated, is a 2-stage amplifier. Power gain is 2,000,000; input impedance, 200 ohms; load impedance, 3,000 ohms; supply frequency, 400 cps at 115 v; response time, 1 second. All necessary rectifiers are self contained. Complete information and specifications are given in bulletin MA.



R-C and L NETWORK in a plug-in unit

EASTERN PRECISION RESISTOR CORP., Richmond Hill 18, N. Y. Complete

Now
STYRACON "B" CAPACITORS

In Wide Range
Of Needed Values
For Critical Applications

Now you can select Sprague Styracon "B" capacitors in the most needed voltage, capacitance, and tolerance values for those critical applications in analog and digital computers, precision timing circuits, etc.

Employing a specially processed polystyrene plastic film as the dielectric, these capacitors have extremely high insulation resistance, freedom from dielectric absorption, extremely low power factor (or high Q), close capacitance tolerance, and unusually excellent capacitance stability. Temperature coefficient of capacitance over the rated operating temperature range of —55°C to +85°C is—100 ppm/°C and practically linear, and is independent of frequency.

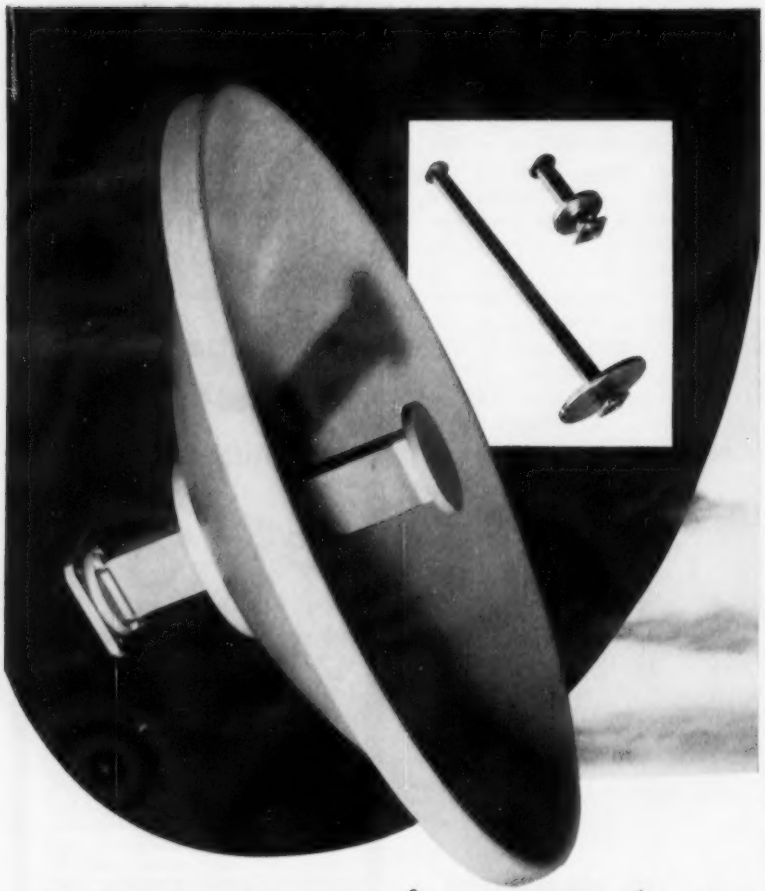
Sprague Styracon "B" capacitors are also available in various mechanical configurations to meet application needs. All are hermetically sealed in metal cases.

Write for Engineering Bulletin 250A, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Mass.

uF	VDC	CATALOG NO.		CASE STYLE
		± 5% TOL.	± 2% TOL.	
.01	200	114P1035252	—	TUBULAR
.01	600	114P1035652	—	
0.1	200	114P1045252	114P1042252	
0.1	600	114P1045652	114P1042652	
0.5	200	111P1J	111P1G	BATHTUB
0.5	600	111P3J	111P3G	
1.0	200	111P2J	111P2G	
1.0	600	111P4J	111P4G	

World's Largest Capacitor Manufacturer

SPRAGUE®



PARABOLIC ANTENNAS *for the* **K** *-band*

Designed and developed by Gabriel to meet or surpass civilian and military specifications for K-band operation, these parabolic antennas are produced with dish diameters of one, two, three, and four feet.

Precision reflectors are illuminated by a modified Gabriel wave-guide feed — the same Gabriel design that has received universal recognition in the 7000-mc commercial relay band. The UG-419/U input flange of this feed is suitable for use in pressurized systems. Three- or four-point adjustable mounting is standard.

- ***Frequency coverage*** *— 12,700 to 13,200 mc.*
- ***VSWR*** *— less than 1.3:1 through entire range*
- ***Each antenna can be spot-tuned*** *to a specific frequency, at slight additional cost.*

Large orders for K-band antennas can be filled quickly; the two-foot and three-foot sizes are available for shipment from stock.

For analysis of your antenna or microwave problems, write us or telephone Needham 3-0005 (through Boston).

GABRIEL ELECTRONICS DIVISION

THE GABRIEL COMPANY Needham Heights 94, Massachusetts

R-C and L networks in a plug-in unit are hermetically sealed to withstand extreme environmental and vibration conditions. Built to customer specification and matched to as close as 0.01 percent these encapsulated packages save valuable chassis space. The illustrated plug-in contains precision wire-wound resistors and polystyrene capacitors aged and matched to within 7 parts per million of each other. The built-in oven maintains a temperature of 75 C.

EXPERIMENTAL KIT
for designers' use

JFD MFG. CO., INC., 6101 16th Ave., Brooklyn 4, N. Y. An engineer's experimental kit, model PK-10 features a selection of 10 of the company's variable trimmer piston capacitors, with pertinent data for each capacitor. The kit was designed for the experimenter and designer in radar, radio, tv, communications, microwave transmission, automation and guided missiles. The capacitors have fused quartz or glass dielectrics and offer such characteristics as: matched temperature coefficients, incremental adjustment of capacitance for highly critical tuning, freedom from microphonics, no tuning backlash and absolute surface resistivity.

S-W DETECTOR
small package, low-cost unit

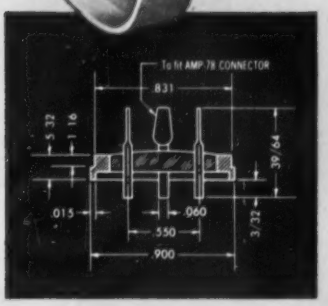
POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. Type 219 standing-wave detector was designed to supersede expensive and bulky slot-

Now! For AMP Taper Pin Connectors

E-I COMPRESSION HEADERS

Type 90 GS/60W-AMP/S Compression Header, available with from 8 to 14 terminals, shown four times actual size.

...offering fast connect and disconnect, speedy assembly and positive connections without soldering!



Available

IN COMPRESSION HEADERS AND PRACTICALLY ALL STANDARD E-I SINGLE TERMINAL EYELETS—

E-I offers single and multiple terminal type compression headers and practically every standard E-I single terminal compression eyelet for use with Type 78 AMP connectors*. For recommendations on specific sealed terminal applications, consult an E-I sales engineer, today!

DAS/60W-AMP/S COMPRESSION TYPE (Actual Size)

FAS/60W-AMP/S COMPRESSION TYPE (Actual Size)

CCAS/60W-AMP/S COMPRESSION TYPE (Actual Size)

ABAS/60W-AMP/S COMPRESSION TYPE (Actual Size)

(Actual Size)

90GS/60W-AMP/S-14A COMPRESSION TYPE

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*Products of Aircraft-Marine Products, Inc. of Harrisburg, Pa.

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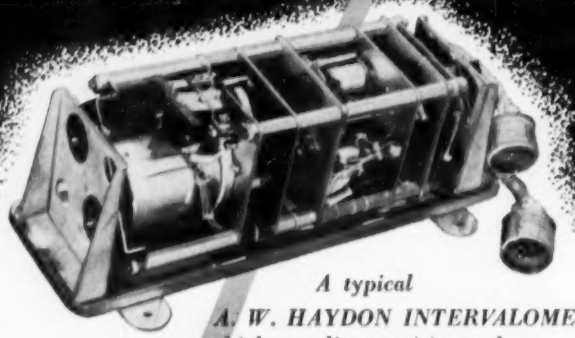
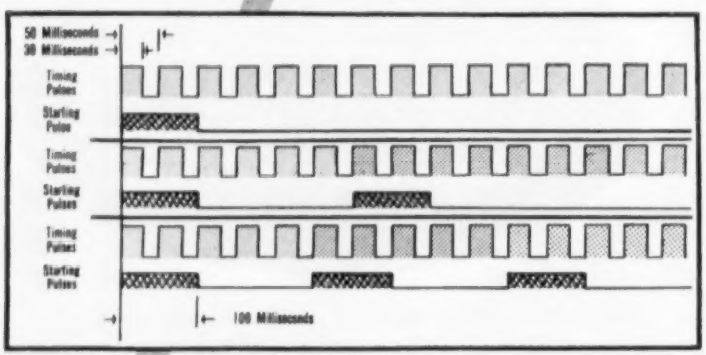
Short Interval Timing Your Problem?

A. W. HAYDON CAN HELP YOU.



A typical
A. W. HAYDON INTERVALOMETER
which supplies precision pulses
as shown on Chart below.



THREE TYPES OF OPERATION

The operator adjusts a selector switch to determine the type of operation.

OPTION #1. When a starting pulse of 100 Milliseconds is applied, this Intervalometer starts up and energizes 15 Pulsing Circuits at 50 Millisecond intervals. Each circuit is on for 30 Milliseconds. At the end of the period, the unit automatically resets to the starting position.

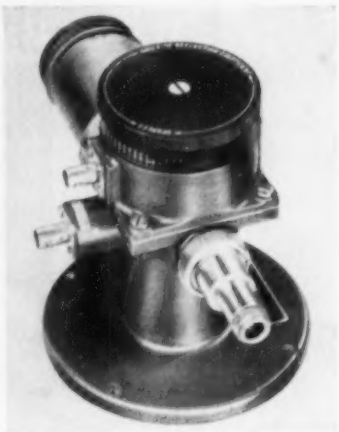
OPTION #2. When a starting Pulse of 100 Milliseconds is applied, this Intervalometer starts up and energizes 6 Pulsing Circuits, then shuts down. When the next starting pulse is applied, the balance of 9 pulsing Circuits are energized. The unit then resets to the starting position.

OPTION #3. When 1st starting Pulse is applied 5 Pulsing Circuits are energized. When 2nd starting Pulse is applied next 5 circuits are energized. When 3rd starting Pulse is applied next 5 circuits are energized.

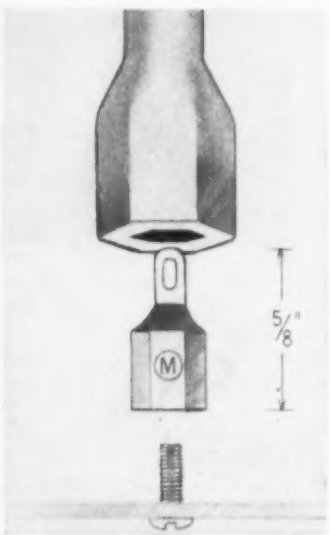
Write for General CATALOG or Submit Detailed Problem Statement.

The A.W. HAYDON Company
235 NORTH ELM STREET, WATERBURY 20, CONNECTICUT

Design and Manufacture of Electro-Mechanical Timing Devices



ted sections in the 100 to 1,000-mc range. It is the small package, low-cost solution for making impedance measurements easily and accurately in this region. By connecting the output to a vswr indicator, such as the PRD type 277, vswr may be read directly on the indicator meter. No special detection equipment is required. The reflection coefficient angle is easily determined merely by rotating the top drum dial to a minimum indication on the meter and reading the angle on the dial directly in electrical degrees. No calculations are required. The probe and crystal detector are self contained. Price of the unit is $475.



CERAMIC CAPACITOR is uhf subminiature type

MUCON CORP., 9 St. Francis St., Newark 5, N. J. In a new stand-off

NUMBER 3 OF A SERIES

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Hoffman Laboratories maintains a highly specialized group of engineers whose entire efforts are devoted to the complex problem of developing and producing specialized tactical test equipment for airborne navigation radar, fire control, missile guidance systems, and other advanced electronic gear. To meet the high standards of quality and reliability set by Hoffman Laboratories, this test equipment group is an integral part of the engineering staff.

For the past 13 years Hoffman Laboratories has been successfully solving advanced design and development problems in electronics. During this time Hoffman Laboratories has never undertaken a development program that has not successfully gone into production.

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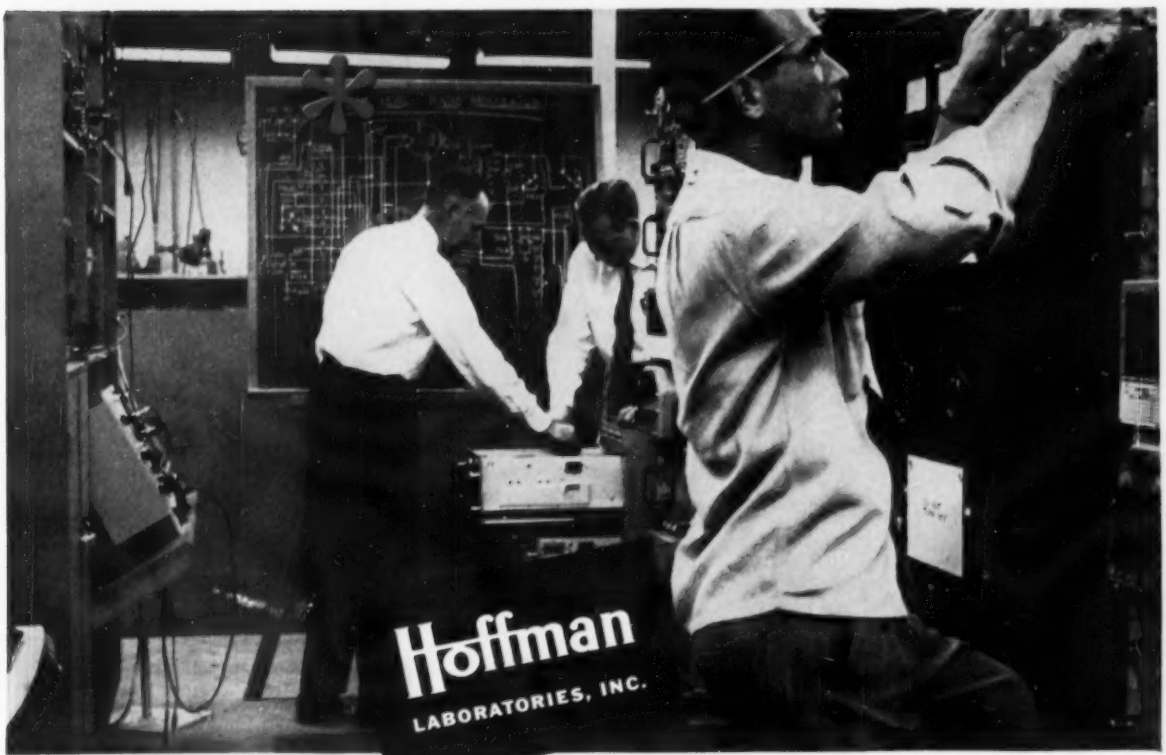

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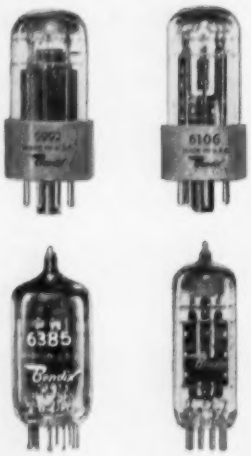
RELIABLE ELECTRON TUBES



With electronic controls taking over more and more operational functions in military and industrial applications, it is becoming increasingly important that the electron tubes used be dependable under extremely severe conditions. This applies particularly to installations in aircraft where tubes must operate reliably at high altitudes, while subjected to continuous vibration, varying voltages and frequent shock. Because of their advanced design and construction . . . born of never-ceasing research and special production skills . . . Bendix Red Bank Reliable Electron Tubes have the dependability necessary to meet these severe operating conditions. You can depend on our long, specialized experience to give you the right answer . . . for all types of regular as well as special-purpose tube applications. Tubes can be supplied to both commercial and military specifications. Call on us for full details.

Manufacturers of Special-Purpose Electron Tubes, Inverters, Dynamotors, AC-DC Generators, Voltage Regulators and Fractional H.P. DC Motors.

DESIGNATION AND TYPE					TYPICAL OPERATING CONDITIONS		
Type	Proto-type	Bendix No.	Description	Base And Bulb	Heater Voltage	Plate Voltage Per Plate	M.A. Load
5838	6X5	TE-3	Full Wave Rectifier	Octal T-9	12.6	350.	70.
5839	6X5	TE-2	Full Wave Rectifier	Octal T-9	26.5	350.	70.
5852	6X5	TE-5	Full Wave Rectifier	Octal T-9	6.3	350.	70.
5993	6X4	TE-10	Full Wave Rectifier	9-Pin Miniature	6.3	350.	70.
6106	5Y3	TE-22	Full Wave Rectifier	Octal T-9	5.0	350.	100.

Type	Proto-type	Bendix No.	Description	Base And Bulb	Heater Voltage	Plate Voltage	Screen Voltage	Grid Voltage	Gm	Plate Current	Power Output
5992	6V6	TE-8	Beam Power Amplifier	Octal T-9	6.3	250.	250.	12.5	4000	45. MA	3.5 W
*6094	6AQ5 6005	TE-18	Beam Power Amplifier	9-Pin Miniature	6.3	250.	250.	12.5	4500	45. MA	3.5 W
6385	2C51 5670	TE-21	Double Triode	9-Pin Miniature	6.3	150.	—	−2.0	5000	8. MA	—

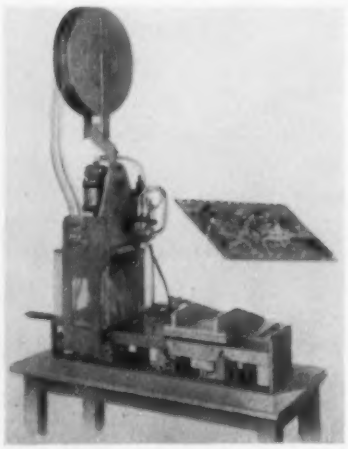
*Tube Manufactured with Hard (Nonex) Glass for High Temperature Operation (Max. Bulb Temp. 300°C.)

Bendix Red Bank DIVISION OF Bendix Aviation Corporation

EATONTOWN, N. J.

West Coast Sales and Service: 117 E. Providencia Ave., Burbank, Calif. • Export Sales: Bendix International Division, 205 East 42nd St., New York 17, N. Y. Canadian Distributor: Aviation Electric Ltd., P.O. Box 6102, Montreal, P. Q.

design, the style S-4 uhf subminiature ceramic capacitor withstands greater shock and stress, and can be more easily installed. It is readily assembled to the chassis with a ¼-in. hex socket wrench which fits the tin-plated ¼-in. hex brass base. The terminal contains an elongated hole to accommodate more than one wire. Overall height is approximately ⅝ in. with 4-40 × ¼ in. deep female mounting hole. A range of values from 3 $\mu\mu$f to 3,300 $\mu\mu$f can be obtained depending on the type of ceramic material required for the application. Bulletin E-1 gives further information.



TERMINAL INSERTER
for printed circuit boards

MALCO TOOL AND MFG. CO., 4025 W. Lake St., Chicago 24, Ill. An automatic machine makes it possible to insert almost any number of terminals into a printed circuit board in two stages within a 3-second cycle. Insertion is accomplished simultaneously in any symmetrical or nonsymmetrical pattern. Since the terminals or pins are self retaining, they will not vibrate loose during additional assembly or other operations prior to permanent soldering. Operation is completely automatic. Terminals or pins in chain form are fed from two reels simultaneously through the die into the printed circuit board feeding mechanism. The machine can be engineered to meet any particular application or production requirement, in accordance with specifications as requested. Bulletin 551,

SUB-MINIATURE S-BAND CAVITIES

2750-3000 mc

Sub-miniature is the word. The new Polarad S-Band cavities are only 3" long and 1" in diameter, yet outperform many larger cavities. They are particularly suited for beacon transmitters, missiles, radar, etc., where miniaturization is a key factor in the choice of components. These cavities withstand vibration, 500 g shock test, 100 g longitudinal acceleration, and are temperature compensated over the range of 0°C to 70°C. They are available for grid-pulsed, plate-pulsed, or CW operation. They may be code modulated by conventional drive circuits using hard tube or gaseous tube types.

All S-Band cavities are factory tuned to the desired frequencies, and can be varied by means of a simple special tool which permits simultaneous frequency and locking adjustment.

FEATURES:

- Extremely small size, 1" x 3"
- Ruggedized pencil triode
- 300 V DC supply is required for grid pulsing
- Temperature compensated
- Meets all MIL specifications
- Fixed low impedance output coupling into 50 OHM BNC connector

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SPECIFICATIONS:

MODEL	Modulation	Power Output	PRF
CGP-1	Grid Pulsed	2 watts peak	0-4,000 PPS
CPP-1	Plate Pulsed	100 watts peak	0-1500 PPS
CCW-1	CW	50 MW	

Tuning Range	2750 — 3000 mc
Pulse Width	0.75 ± 0.1 μSec.
Rise Time	0.1 μSec.
Frequency Stability	0.02 mc/°C.

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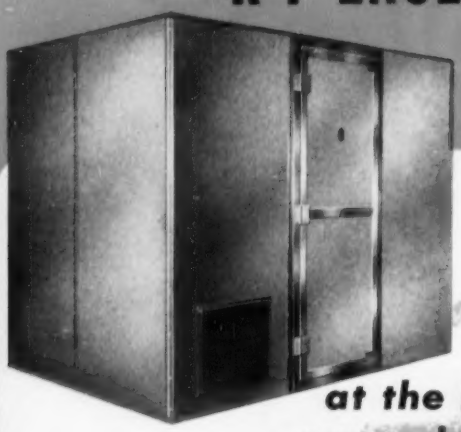
NOW SHEET METAL R-F ENCLOSURES



at the lowest price ever

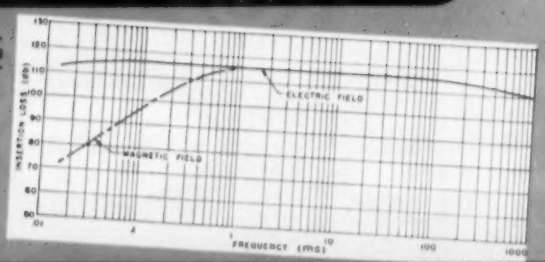
Offering all the advantages of sheet metal construction, Ace's new *galvanized* sheet metal enclosure is easily erected — ideal for use indoors or out — readily weather-proofed for any climate — safely transported assembled or disassembled — ideally suited for mobile units—constructed to take a real beating in the toughest kind of service.

Furthermore, you get top attenuation across the entire frequency range, typical of all Ace shielded enclosures. See curve below.

This new low priced enclosure uses the famous patented Lindsay Structure, with solid 24 gauge galvanized steel panels fastened to rigid steel channels forming leak-proof seams. Service entrances can be provided to meet every need, from power and water to forced air ventilation or air conditioning systems.

Get complete information now on this new solution for your r-f interference problems. Write for new catalog which contains performance and construction data on every type of ACE Shielded Enclosure.

Plotted by an independent electronic interference measurement laboratory.



SHIELDED ACE ROOMS

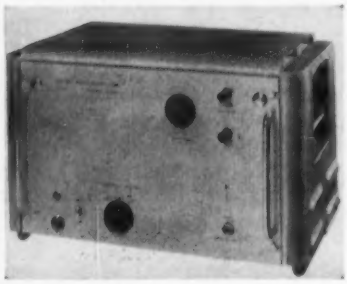
ACE ENGINEERING & MACHINE CO., INC.

3644 North Lawrence Street · Philadelphia 40, Pennsylvania

now available, gives further information.

NETWORK
provides pulse formations

ESC CORP., 534 Bergen Blvd., Palisades Park, N. J. Model No. 21-19 network provides pulse formations from 0.25 μsec to 2.0 μsec in width by three miniature toggle switches. Circuit is arranged to provide a residual pulse width of 0.25 μsec at all times. Other features of the compact delay network include an impedance of 200 ohms ±10 percent with a 35-percent maximum attenuation for 2.0 -μsec delay of the reflected pulse. Each delay network is potted in epoxy resin and enclosed in an hermetically sealed case. The entire assembly is further enclosed in a dust-proof case and is finished in accordance with MIL-T-945A salt spray and humidity conditions. Glass compression type terminals are provided for all connections.



GENERATOR
produces square waves

THE SOLARTRON ELECTRONIC GROUP LTD., Thames Ditton, Surrey, England. Model GO.511 generator produces square waves at 1 mc, 100 kc, 10 kc and 50 cps; the rise time of the 1-mc signal being between 30 and 40 μsec, and the fall time less than 25 μsec. At the other output frequencies the rise and fall time is in the same ratio (1:40) to the signal frequency. The 10-kc and 100-kc square waves have rise times which are ideally suitable for the adjustment of feedback amplifiers. The generator provides a constant output of 10 v across 75 ohms load, and at 50 cycles only, a continuously

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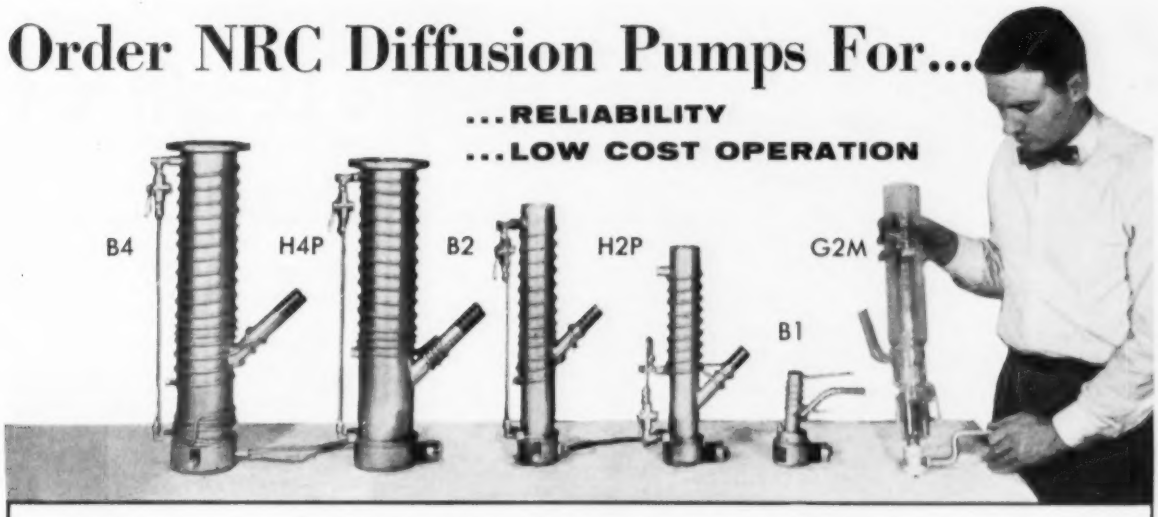
...RELIABILITY

...LOW COST OPERATION



OPERATING SPECIFICATIONS

Model	Liters/ Sec.	Cu. Ft./ Min.	Max. Oper. Pressure mm Hg	Blank-off (1)	Fore-Pressure	Recommended Fore Pump Capacity	Recommended Fore Pump Model	Pumping Fluid Narcoil #	Fluid Capacity c.c.	Water Requirements g.p.m.	Power Requirements Watts	Price (2)
DIFFUSION PUMPS												
H-2-P	70	147	.01	1.5×10^{-8}	.18	3 c.f.m.	NRC 4S or 4D	40	85	.2-.3	200	$125.
H-4-P	300	637	.01	1.0×10^{-8}	.25	7 c.f.m.	NRC 6S or 6D	40	250	.5-1.0	500	235.
H-4-SP	300	637	.01	1.5×10^{-8}	.25	7 c.f.m.	NRC 6S or 6D	40	250	.5-1.0	500	200.
H-6-P	730	1550	.01	1.5×10^{-8}	.20	30 c.f.m.	NRC 30S or 30M	40	400	1-2	950	370.
H-10-P	1700	3600	.01	1×10^{-8}	.10	50 c.f.m.	NRC 100S or 100M or 30M	40	1000	2-4	2300	675.
H-16-P	5000	10600	.01	1.8×10^{-8}	0.3	100 c.f.m.	NRC 100S or 100D	40	800	2-4	3000	1200.
BOOSTER PUMPS												
B-1	8.5	18	.10	4×10^{-4}	.20	1 c.f.m.	NRC 2S or 2D	10	25	.1-.15	85	57.
B-2	72	153	.30	1.5×10^{-4}	1.0	8 c.f.m.	NRC 15S	10	175	.5-1.0	450	175.
B-4	220	465	.30	1.5×10^{-4}	1.45	12 c.f.m.	NRC 15S	10	375	.4-.6	1350	325.
B-6	520	1100	.30	2.5×10^{-4}	.90	100 c.f.m.	NRC 100S	10	11360 (3 gal)	2-4	6000	930.
H-10-P	2000	4240	.30	1.5×10^{-4}	.28	50 c.f.m.	NRC 100S or 30S	10	1000	2-4	2300	675.
GLASS PUMPS												
G-2-M	28	59	.10	8×10^{-7}(3)	.50	3 c.f.m.	NRC 4S or 4D	Hg	100	1-2	300	204.(4)

(1) Ion gauge measurements (total pressure)
(2) Incl. std. flanges except B-1
(3) With liquid nitrogen cold trap
(4) Incl. initial charge of mercury

Check the high throughput, high forepressure tolerance, low blank-off and other performance specifications in the table above, and then consider: *You can rely on NRC PERFORMANCE-PROVED pumps to meet these specifications day after day* because:

. . . Performance is unaffected by normal variations in line voltage and cooling water characteristics.

. . . Heavy aluminum self-centering jets are hard to damage — jet spacing is not critical.

. . . Pumps are designed to operate with rugged pump oils which resist breakdown and oxidization.

. . . Jets are virtually self-cleaning — no small apertures to get clogged.

. . . "Cast-in" heaters give exceptional life — are readily accessible for cleaning.

. . . Stainless-steel bodies stay clean — do not rust.

. . . Backstreaming is minimized.

. . . NRC glass mercury vapor pumps are assembled on a production basis to assure reproducible performance, interchangeability of components, easy disassembly for cleaning.

CUT DIFFUSION PUMPING COSTS with

NARCOIL 40

NEW Reduced Cost

$38.50 Per Gal.

Unequalled in its combination of stability and low blank-off.

NRC

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Subsidiary of NATIONAL RESEARCH CORPORATION
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IN COMPACTNESS

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2 degrees of freedom
. . . 360° in roll, ±82° in pitch
Repeatability to established vertical
. . . 15 Minutes max. of ½ cone angle
Free drift rate
. . . 0.5°/Minute
Erection Time
. . . 3 minutes at start
Erection Rate
. . . 3°/minute-Normal 80°/minute-Fast
Synchro Output (each axis)
. . . 11.8 volts, 400 cycles

Only Kearfott can offer a *Miniature* Vertical gyro with big gyro *Performance*. Completely self contained, this gyro requires *No External Erection Amplifiers*. A gravity sensitive electrolytic device, within the gyro, directly associated with the torquer motors, provides the necessary vertical reference.

Hermetically Sealed, filled with a dry, inert gas. Satisfies the requirements of MIL-E-5272 as regards shock test (Procedure II) humidity, salt spray, fungus resistance, rain, sand, dust, immersion and explosion proof.

This gyro duplicates the performance of the Kearfott T2108 series in ⅛ *the volume and weight.*

KEARFOTT COMPONENTS INCLUDE:
Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

Engineers: Many opportunities in the above fields are open. Please write for details today.

Kearfott

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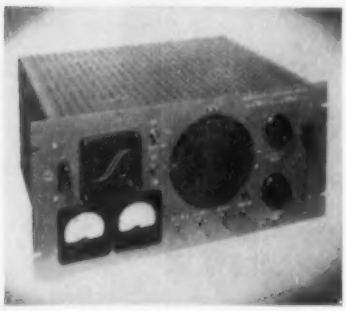
variable output from 0 to 18 v across an impedance of not less than 2,000 ohms. The output pulses may be reduced in amplitude by the external use of a Solartron 75-ohm, 60-db attenuator, or may be differentiated in the normal manner by connecting a resistance-capacitance network across the 75-ohm output terminals.



WIDE-RANGE BRIDGE
for production line and lab

WATERS MFG., INC., 4 Gordon St., Waltham 54, Mass. A new wide-range incremental-inductance bridge will measure from 0 to 5, and 5 to 180 henrys at any frequency from 60 to 1,000 cps. Completely versatile in its use to measure small choke coils, toroids, relay coils, audio filter coils and similar applications, it permits independent variation of a-c voltage from 0 to 135 rms, and d-c from 1 to 500 ma. The test inductor resistance may be up to 750 ohms at 500 ma. Ruggedly built, it provides for fast accurate measurements on production lines, and its 3-percent accuracy makes it also suitable for lab use.

TUBULAR CAPACITOR
for —55 C to +100 C operation

CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J. The Tiger Cub type MGT paper dielectric

For High Q and Excellent Capacitance Stability

CP

PLASTICON CAPACITORS are made with NATVAR Styroflex®

CP Plasticon Type P Capacitors are available with metal can containers in 22 capacities ranging from 0.1 mfd at 1000 vdc to 25 mfd at 100 vdc; and with tubular "Glass-mike" containers in 22 capacities from .001 mfd at 1000 vdc to 1.0 mfd at 100 vdc.

Capacitors designed and manufactured by Condenser Products Co., Division of New Haven Clock & Watch Co. are extensively used in calculators, computers, integrating circuits, electronic controls, sawtooth oscillators, and other equipment where stability and low dielectric loss are important.

Natvar Styroflex film is used as the dielectric because it has all of the outstanding properties of polystyrene, plus complete flexibility due to bi-axial orientation during the manufacturing process.

If you need an insulating material with the desirable characteristics of polystyrene—plus flexibility, it will pay you to investigate Natvar Styroflex. Ask for new data sheet ST-1, just off the press.

Natvar

Natvar Products

- Varnished cambric—cloth and tape
- Varnished canvas and duck
- Varnished silk and special rayon
- Varnished—Silicone coated Fiberglas
- Varnished papers—rope and kraft
- Slot cell combinations, Aboglas®
- Vinyl coated—varnished—lacquered tubing and sleeving
- Extruded vinyl tubing and tape
- Styroflex® flexible polystyrene tape
- Extruded identification markers

Ask for Catalog No. 23

NATVAR CORPORATION

FORMERLY THE NATIONAL VARNISHED PRODUCTS CORPORATION

TELEPHONE RAHWAY 7-8800 — CABLE ADDRESS NATVAR: RAHWAY, N. J.

201 RANDOLPH AVENUE • WOODBRIDGE, NEW JERSEY

HIGH VOLTAGE RESISTORS — UP TO 125,000 VOLTS!

RESISTANCE VALUES TO 1 MILLION MEGOHMS!

Widely renowned for stability and reliable performance, RPC's High Voltage resistors are successfully used as VT voltmeter multipliers; high resistance voltage dividers; bleeders in high voltage power circuits; corona resistors and standards of high resistance value. They are eminently suitable for use in television transmitters and receivers, cathode ray tube circuits, X-ray equipment, Van de Graff generators, electro-meter tube circuits, pulse circuits, dust precipitators, photo cell applications and high voltage circuit equipment. Leading laboratories, manufacturers and many government agencies specify RPC High Voltage Resistors.

TYPE B. From 1 to 6½ inches long; diameter 5/16 to 7/16 inches. Voltages to 40 KV. High stability carbon coating on strong non-hygroscopic steatite rod. Very long effective resistor length in small space is due to application of coating as a helix on rod's surface. Thus, resistance coating of relatively low specific resistance produces stable resistors of high resistance value. Ends of resistors permanently connected with silver contact coating.

Type B resistors are readily mounted on panel or stand-off insulators. Can be assembled as tapped resistors and matched pairs. Temperature and voltage coefficients are low.

TYPE D. Provide voltage rating up to 125 KV and load capacity up to 90 Watts. From 6½ to 18½ inches in length. Made on steatite tubes and can be supplied with silver contact bands, band type terminals or lug ferrules.

In both types, B and D, standard resistors tolerance is ±15%. Tolerances of ±10%, ±5%, or ±3% can be supplied. A tolerance of ±2% can be supplied in matched pair resistors.

Write for additional details and catalog.

Hermetically sealed and encapsulated resistors available. For special assemblies, special types and sizes consult our Engineering Department.

RESISTANCE PRODUCTS CO.

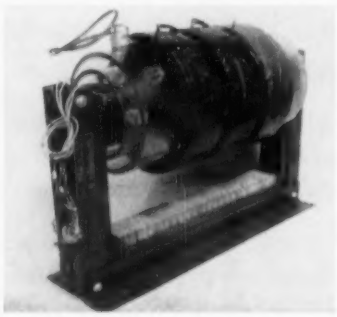
914 South 13th Street Harrisburg, Penna.

Makers of Resistors—High Megohm, High Voltage, High Frequency, Precision Wire Wound.

tubular capacitor is designed to operate effectively at temperatures from −55 C to +100 C. An external wax dip provides added moisture protection that will withstand 250 hours of continuous exposure in 90-percent relative humidity at 40 C. The capacitors are available in capacitances from 0.001 μf to 1.0 μf in 6 voltage ranges from 100 to 1,600 v d-c working. Low resistance lead wires are soldered to extended foils and held firmly in place by Polykane, the high temperature, nonmelting end fill.

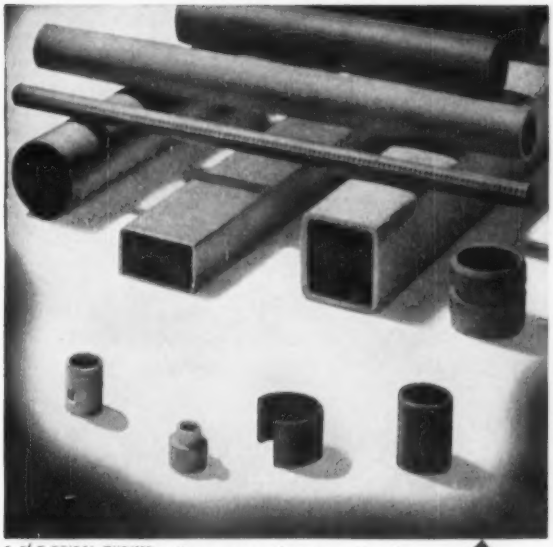
N-P TESTER
for semiconductors

BAIRD ASSOCIATES, INC., 33 University Road, Cambridge 38, Mass., has introduced a new test instrument for determining *n* or *p* type conductivity. Model JR1 is designed around a convenient thermoelectric probe constructed with spectrographically pure graphite electrodes to minimize sample contamination. Electrode heating is accomplished with a 110-v a-c heater, readily controlled by accessible switches on the front panel of the tester. In operation, the sample under test is brought into contact with the electrode probes. Direction of deflection of a compactly built, easily readable pointer-type galvanometer reveals conductivity type of the sample.



H-V TRANSFORMER
using polystyrene

POWER TRANSFORMER CO., INC., 532 Mulberry St., Newark 5, N. J. Transformers up to 320 kv rms have been built to deliver close to 1,000,000 v d-c, using a voltage doubler circuit, up to 300 kv d-c in a full-



C-D-F SPIRAL TUBING offers many advantages to the cost-conscious design engineer and purchasing agent. It is low-cost, moisture-resistant, high-strength, and easy to fabricate. It has sufficiently low dielectric loss properties and good dielectric strength for many applications.

New C-D-F Plastic Spiral Tubing reduces unit costs, improves products

Using C-D-F's new Spiral Tubing is a way of saving money in buying electronic insulation . . . without lowering the electrical and mechanical characteristics of the part required. This special tubing is a high-strength plastic made from paper or vulcanized fibre that is spirally wound. It is available in two basic forms in various grades: (1) as plain untreated tubing. (2) as impregnated tubing containing various types of thermosetting insulating varnishes.

BUY ONLY THE PROPERTIES YOU NEED

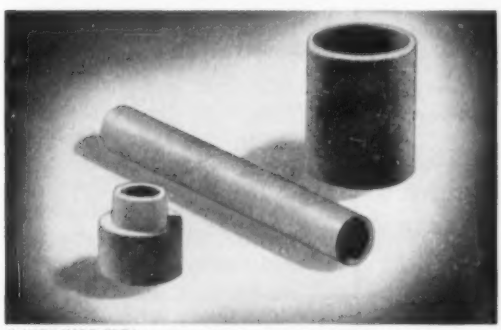
Spiral Tubing can be used to replace rolled or molded laminated phenolic tubing in many cases. As the degree of moisture resistance and mechanical strength is established during the manufacturing process, you specify . . . and buy . . . only those properties required for the application. C-D-F also offers complete designing, machining and assembly. You can get finished components, or random length tubing, with fast deliveries. Write for Technical Folder ST-53 and samples, after checking our catalog in Sweet's Design File. Call the C-D-F sales engineer listed there—he can save you time and money immediately with C-D-F Spiral Tubing!

CDF

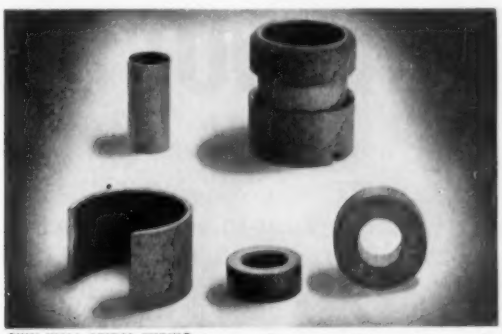
Continental-Diamond Fibre

CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.

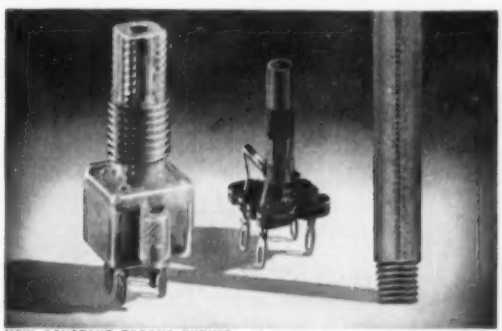
NEWARK 16, DELAWARE



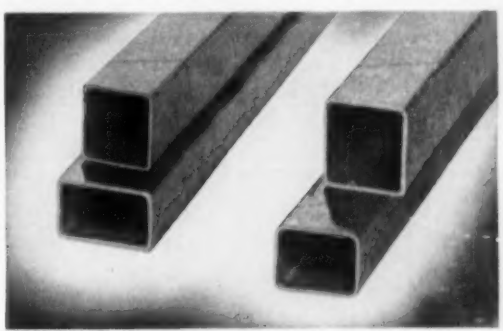
A VERY HARD TUBE is supplied in C-D-F Grade 6A. The parts shown have maximum mechanical strength, lowest water absorption rate under immersion conditions and most stable dielectric loss properties. Fine for bushings and cores.



THIN-WALL SPIRAL TUBING has good concentricity and is tough. Note thin wall construction, cleanness of machining, variety of shapes. C-D-F Spiral Tubing is easily machined, formed, punched. Made in many grades for special applications.



NEW CONSTANT TORQUE TUBING, for permeability tuning with iron cores, features exact internal threading with three point suspension of the core to prevent binding . . . *no* external embossing to lower dielectric strength. Write for samples.



HARD OR SOFT, square or rectangular coil-form tubing is made for solenoid and transformer applications. Sides are straight with minimum gap in paper winding. Supplied in soft, varnished kraft, or hard, rigid tubing.

RATE OF CLIMB WITHOUT DELAY

THE TRANS-SONICS® VERTICAL SPEED TRANSDUCER provides 0 to ±5 volts output linearly proportional to vertical speed over its range of ±25,000 ft./min. rate of climb or dive.

The instrument has a delay of only 0.2 sec. at sea level and less than 2 sec. at 50,000 ft.

There are no moving parts or linkages in the Vertical Speed Transducer. It is designed for rugged service aboard aircraft and missiles.

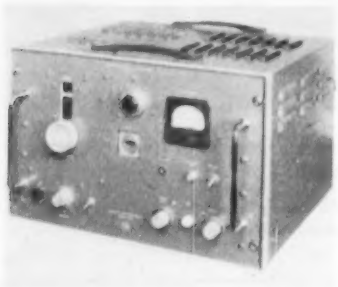
Remote dial indicators for pilot's display are available.

Request technical data on the Trans-Sonics Vertical Speed Transducer.

For Transducers see Trans-Sonics

TRANS-SONICS, INC.
5 FOREST STREET, BEDFORD, MASS.

wave bridge, resistive load or up to 400 kv d-c capacitive load. Input can be 115 v to 230 v or any input voltage at any frequencies from 25 to 3,200 cps, depending upon individual design, which allows for leakage inductances and distributed capacitances factors as function of input frequency. Illustrated is a 55 kv rms transformer capable of delivering 150 kv d-c at 0.1 ampere in a voltage doubler or 50 kv d-c at 0.3 ampere continuous duty.



MICROWAVE OSCILLATOR
is ultrastable

LABORATORY FOR ELECTRONICS, INC., 75 Pitts St., Boston 14, Mass. Featuring an automatic stabilization indicator, a new model in the line of stabilized microwave oscillators has just been announced. Model 814 is a frequency generator in the X-band region which makes use of a discriminator and feedback loop to secure short term stabilization in the order of 5 parts per hundred million. It also features simplified tuning which makes it possible for inexperienced personnel to use the instrument in routine testing. The tuning dial is calibrated to read directly in frequency. The tuning range of the oscillator is from 8,500 mc to 10,000 mc.

METALLURGICAL WIRES
for semiconductors

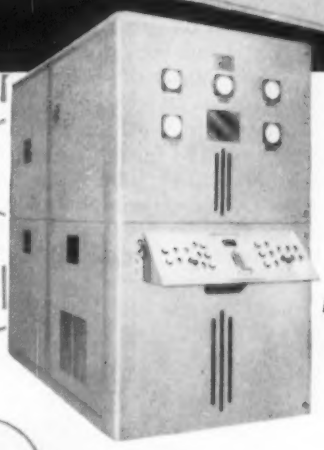
SECON METALS CORP., 7 Intervale St., White Plains, N. Y., has introduced several new metallurgical wire products specifically researched and developed for application in the fields of semiconductors, transistors, diodes and crystals. The products include gold and aluminum

FXR MODULATORS • PRECISION MICROWAVE TEST EQUIPMENT • RADAR, RELAY, MISSILE COMPONENTS

Custom Electronic Components

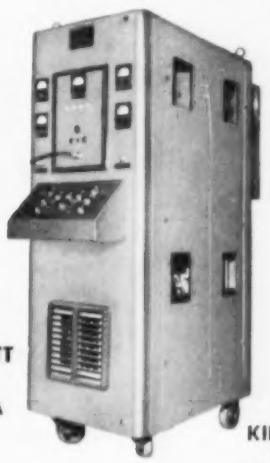
MODULATORS
for
MAGNETRONS and KLYSTRONS

When industry and experimental laboratories need special instruments, designed and built to the highest standards of **precision performance** and at **lowest cost**, they turn to FXR for proved dependability. A good example of close integration between FXR engineering design and production, typified in the illustration, shows an electromechanical engineer working on a design change to **accommodate a customer's special requirements**. Got a design problem? Try FXR first!



14 MEGAWATT UNIT
Type Z821A

ONE MEGAWATT UNIT
Type Z820A



625 KILOWATT UNIT
Type Z824A

BASIC DESIGNS NOW AVAILABLE

High Power Modulator Type No.	Power (peak megawatts)	Voltage (peak kilovolts)	Current (peak plate-amperes)	Impedance (output-ohms)	Duty Cycle (maximum)	Pulse Shape (μsec/pps)	Input 60 CPS (Φ/volts)	Size (HxWxD, ft.)	Weight (lbs.)	Tubes Operated
Z820A	1.0	33	33	1,000	.001	0.5/2000 2.5/400	1/190-250	6x2x3	1400	4J50, QK-349 RK-6249
Z821A	14.0	90	160	560	.001	2.0/200-500	3/440-550	7x4x7	6800	QK-338
Z822A	0.2	20	10	3,330	.018	10/1200-1800	3/440	6x3x4	3330	SAL 39 (GL-6625)
Z823A	0.042	12.7	3.3	3,330	.064	coded/300	3/440	6x4x4	3200	SAL 39
Z824A	0.625	25	25	1,000	.001 at 0.5/2000	1.0/1000 2.0/250 5.0/100	1/190-250	6x2x3	2500	QK-349 at reduced power
Z825A	1.6	40	40	1,000	.001 at 0.5/2000	1.0/1000 2.5/400	1/190-250	6x2x3	2500	WE-5780

Modulator Loads and Exhaust Ovens are also available.

Duty subject to change without notice. Write us for application.

FXR ELECTRONICS & X-RAY DIVISION · F-R MACHINE WORKS, INC. ·

FIRST BY FAR

Electronics & X-Ray Division

F-R MACHINE WORKS, Inc.

26-12 BOROUGH PLACE, WOODSIDE 77, N. Y. • ASTORIA 8-2800

Recent word in certain of our dignitaceous* monthly periodicals gives nick-of-timely surcease to those indefatigable oracles of Eras, New Eras and Vast New Eras; viz., largest machinery manufacturers have joined giants of electronics and given birth to a *New* Vast-New-Era. ; *The Automatic Production of Electronic Equipment.*

Although as yet no printed material on specific applications is available to the lay public, no time should be lost in devising a suitably architiptic name for this Science which results from the wedding (shotgun — ?) of Electronics and Automation.

Thus, the Sigma CONTEST, in which the modesty of the prizes is far exceeded by the wealth of satisfaction which will accrue to the winner from the knowledge of the importance of his contribution.

B I G S I G M A C O N T E S T

RULES

1. Entry must include name for Electronics combined with Automation, and brief statement explaining reasons for choice.
   Hints: Electromation? Elematics? Electautos? Mechelecs?
2. Judges agree to reach a final biased decision. Answers to inquiries concerning individual entries cannot be guaranteed. All entries do become the property of Sigma Instruments, Inc.
3. All entries must reach Boston by October 1, 1955.
4. Sigma Instruments, Inc., disclaims any liability resulting from patent infringement, copyright violation or intra-industry squabbles.
5. If you have a state law prohibiting this contest we suggest that you move.

PRIZES ★ PRIZES ★ PRIZES

Grand Prize One Sigma Type 72 Relay complete with Data Sheet (Excellent mantelpiece ornament).

2nd Prize One Fisher-Pierce Photoelectronic Nitelighter (Start your collection of people-built antiques).

3rd, 4th and 5th Prizes One Sigma Type 26F Relay with 1 year subscription to POPULAR ELECTRONICS.

Honorable Mention Certificate of Merit, suitable for framing, signed by C. P. Fisher.

Booby Prize Picture of our founder.

*patent pending

SIGMA

SIGMA INSTRUMENTS, INC.

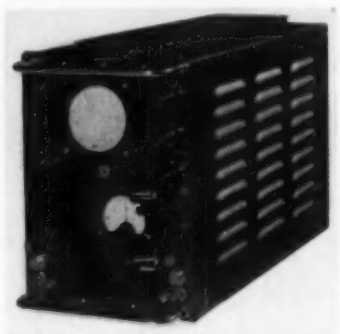
CONTEST HEADQUARTERS

931b Statler Building, Boston 16, Massachusetts

wires, whisker wires in base metals as well as hard platinum alloys, and lead wires of a great variety such as tinned copper wire or ribbon.

PLUG-IN AMPLIFIER
is chopper-stabilized

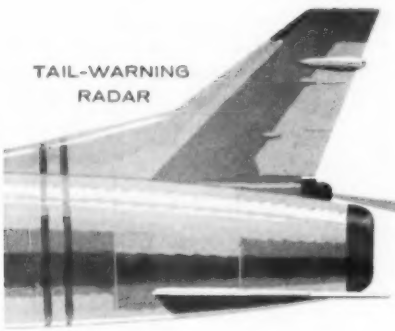
ELECTRO DEVELOPMENT ASSOCIATES, INC., 6403 Cary Drive, Austin, Texas. Model OS3 operational amplifier is a chopper stabilized, miniaturized, plug-in type. Dimensions are $5\frac{1}{4}$ in. × $5\frac{7}{8}$ in. × $1\frac{3}{8}$ in.; weight, 15 oz; gain, 4.5×10^7 open loop. Power requirements are 6.5 ma at +300 v d-c; 4.5 ma at −300 v d-c; 0.94 ampere at 6.3 v, 60 cycles. Input impedance is over 100 megohms. Output is −50 v d-c to +50 v d-c, −1 ma to +1 ma into a 50k load.



OSCILLOSCOPES
in two new models

THE SOLARTRON ELECTRONIC GROUP LTD., Thames Ditton, Surrey, England. Models CD.518 and CD.568 oscilloscope give high brilliance of trace and are fitted with rubber masks to facilitate viewing. The CD.518 has an internal time marker generator providing marker pips at 1-μsec or 10-μsec intervals

specialized radar... made by specialists



BENDIX PACIFIC AIRBORNE RADAR

Bendix-Pacific has the *specialized* engineering talents, the production facilities and the know-how to develop and build the *exact* radar for your requirements.

The experience Bendix-Pacific has already acquired in developing many advanced types of radar equipment and systems offers you a *plus value* that can mean excellence in design and efficiency in manufacture for *your* systems projects.

Let us place a qualified radar systems engineer at your service. He will be glad to visit you at your convenience.

If you are a highly qualified radar engineer, Bendix-Pacific offers you an excellent future. Write for details.

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from 0.1 M.F.D.
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• Dissipation Factor-.0002
• Temp. Coeff.(-20° to 140° F.)
100 P.P.M. per °C
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Electronic Associates, Inc., Convair,
Berkeley Scientific, M.I.T., Calif.
Inst. of Tech., and many others.
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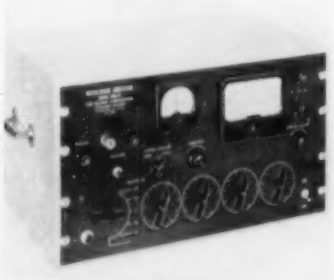
SOUTHERN ELECTRONICS
Corporation
239 West Orange Grove Ave., Burbank, Calif.

and also a 1-mc sine wave calibration facility. This marker signal may be adjusted readily with respect to the main input trace in order to accurately measure time intervals and time base velocities. The CD.568 gives 1 mc, 100 kc and 10-kc sine-wave outputs. A loose-leaf perforated catalog sheet gives complete specifications.

PULSE FORMING NETWORK
meets military specs

E. S. C. Corp., 534 Bergen Blvd., Palisades Park, N. J. The No. 11-54 pulse forming network forms two 0.6-μsec pulses at 12-ohm impedance and 500-v d-c working. The entire unit measures only $1\frac{5}{8}$ in. × $1\frac{1}{4}$ in. × $1\frac{1}{8}$ in.



LAB INSTRUMENT
analyzes resistance

The Kuljian Corp., 1200 N. Broad St., Philadelphia 21, Pa. Model KED-15 resistance analyzer is capable of accurately measuring the voltage coefficient of resistors over a variety of ranges from 1,000 ohms to 1,111 megohms to within 0.1 percent. It was designed to check such characteristics as d-c resistance, temperature coefficient, and voltage coefficient of resistors according to

TAYLOR Laminated Plastics Vulcanized Fibre

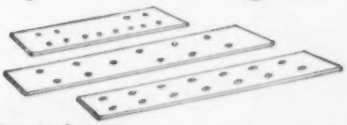
Shop Talk

TAYLOR FIBRE CO.

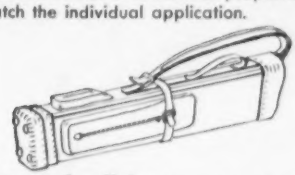
Plants in Norristown, Pa. and La Verne, Calif.

PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD

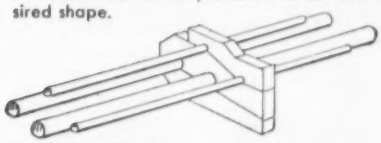
Tips for designers



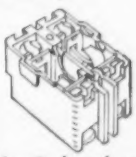
Terminal strips for aircraft electronic equipment Grade GEC epoxy laminate, and of Grade 353 and Grade C phenol laminate . . . each chosen for properties to match the individual application.



Bottom of golf bag is made of Taylor Vulcanized Fibre . . . a tough, abrasion resistant material readily formed to the desired shape.



Fuel line clamp for a fighter airplane's "pipeline" system is machined from Taylor fabric base laminate which has high mechanical strength and resists extreme temperature and humidity.

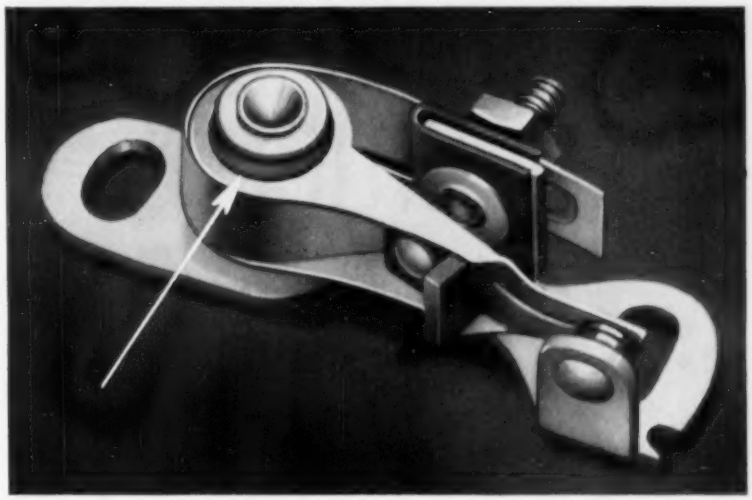


Liners for circuit breakers are made of Taylor Vulcanized Fibre, whose arc-resistant properties protect the breaker's molded base from the damaging effects of arcing at the breaker points.

Taylor Fabricating

FACILITIES

Your production problems can often be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts of vulcanized fibre and laminates to your specifications. Efficient, modern facilities are ready to serve you. Write to Taylor about your specific requirements.



Distributor breaker assembly uses Taylor XX laminated tubing for the contact arm bushing. This paper base laminate maintains high dielectric strength under humid conditions, has good dimensional stability and machines readily.

Design for performance and economy— *with Taylor Phenol Laminates*

You can be sure of getting performance to fit your product at a price to fit your budget, when you design with Taylor phenol laminates. More than thirty different grades offer you a broad combination of electrical, physical and machining properties that cover a wide range of product applications.

Included in this selection of materials are paper and fabric base grades. Notable among these is a family of hot punch laminates—the new "300" series. Especially developed for the increasingly stringent demands of modern electronics, this series marks a new high in ease of fabrication and economy . . . plus exceptional stability under all climatic conditions.

You'll find that Taylor laminates can lead to real economies in production, through their excellent punching, staking and machining qualities. They come in forms that permit efficient production of varied shapes . . . sheets 49″ by 49″, tubes and rods. And they're a real bargain in performance, often giving you properties found only in premium-priced materials.

Equally important, you're always sure of quality. Taylor formulates its own resins . . . manufactures its own special grades of paper . . . all under the strictest laboratory control.

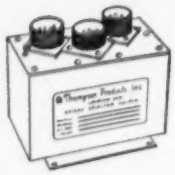
Write today for a copy of the general catalog on these and other Taylor materials. And ask a Taylor specialist to see you for a consultation on your specific materials selection problem.

Thompson's Magnetic Amplifier

How to "borrow"

...ideas ...facilities ...experience

Thompson's Airborne Rotary Selector Switch



from Thompson

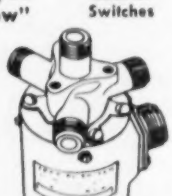
FOR help in untangling knotty electronics problems, many manufacturers have learned to "*count on Thompson*".

Ideas? To Thompson electronics engineers, no research, development or production problem is "unsolvable". Given the opportunity, they'll come up with sound ideas to solve *your* electronics problems. **"Borrow" those ideas!**

Facilities? Complete development and testing laboratories . . . plus the most modern production equipment . . . are available to Thompson's electronics engineering staff. **"Borrow" these facilities!**

Experience? Thompson has had 53 years of successful problem-solving for the automotive, aircraft and general industries of America. The highly developed skills and combined experience of the entire Thompson organization are available to you for all your electronics problems. **"Borrow" this experience!**

One of the many Thompson Coaxial Switches

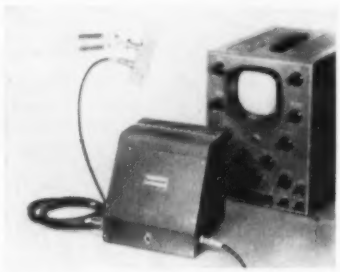


Electronics Division

Thompson Products, Inc.

2196 CLARKWOOD RD., CLEVELAND 3, OHIO

capacity of 2 w can be determined down to as low as 0.0002 percent per v. The voltage across the measured resistance is continuously variable in 3 ranges from 0 to 500 v by a self-contained regulated power supply. Resistors can be readily measured with good sensitivity with voltages as low as 0.5 v. The unit measures 19½ in. × 11 in. × 12 in. deep.



CORONA DETECTOR
is safety type

SUNSHINE SCIENTIFIC INSTRUMENT, 1810 Grant Ave., Philadelphia 15, Pa. The detector illustrated determines the presence of corona in h-v rotating apparatus. The unit consists of a probe mounted on the end of an insulating pole, a control unit and cables. It is connected to a standard oscilloscope for a visual corona reading. The equipment is inexpensive, portable, safe and easy to use, and can prevent damage, shutdown and material spoilage. Catalog No. 17 describes the instrument in detail.

POTENTIOMETERS
are high-resolution type

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. Series K-200 high resolution poten-

For Quality, Accuracy & Dependability

USE THESE FREED TELEMETERING COMPONENTS

TELEMETERING BAND PASS FILTERS

Covers the frequency band from 400 cps to 70 kc. 3 DB Band width ±9¾% of center frequency. Features octal "plug in" header. Size 2⅛" x 3½" x 4½".

CHARACTERISTIC IMPEDANCE 2500 OHMS		
FREED #	CENTER FREQUENCY	3 DB BAND WIDTH
FBP-34	400 cps	± 9¾% CF
FBP 35	560 cps	± 9¾% CF
FBP 36	730 cps	± 9¾% CF
FBP-37	960 cps	± 9¾% CF
FBP 38	1300 cps	± 9¾% CF
FBP 39	1700 cps	± 9¾% CF
FBP-40	2300 cps	± 9¾% CF
FBP-41	3000 cps	± 9¾% CF
FBP-42	3900 cps	± 9¾% CF
FBP-43	5400 cps	± 9¾% CF
FBP-44	7350 cps	± 9¾% CF
FBP-45	10500 cps	± 9¾% CF
FBP-46	12300 cps	± 9¾% CF
FBP-47	14500 cps	±19½% CF
FBP-48	22 KC	± 9¾% CF
FBP-49	22 KC	±19½% CF
FBP 50	30 KC	± 9¾% CF
FBP-51	30 KC	±19½% CF
FBP-52	40 KC	± 9¾% CF
FBP-53	40 KC	±19½% CF
FBP 54	52.5 KC	± 9¾% CF
FBP-55	52.5 KC	±19½% CF
FBP 56	70 KC	
FBP 57	70 KC	

CHARACTERISTIC IMPEDANCE 500 OHMS

Band pass filters FBP-10 through FBP-33 feature the same attenuation characteristics as the above listing and are supplied with solder lug terminals.

DISCRIMINATOR INPUT LOW PASS FILTERS

Covers the frequency band of 400 cps to 70 kc. Less than .05 DB attenuation at ±9¾% of center frequency. 30 and 50 DB attenuation at the third and fifth harmonic of the pass band frequencies. Size 1½" x 1½" x 4½".

CHARACTERISTIC IMPEDANCE 30,000 OHMS

LPI —	Fo
10	400 CPS
11	560 CPS
12	730 CPS
13	960 CPS
14	1300 CPS
15	1700 CPS
16	2300 CPS
17	3000 CPS
18	3900 CPS
19	5400 CPS
20	7350 CPS
21	10.5 KC
22	12.3 KC
23	14.5 KC

CHARACTERISTIC IMPEDANCE 5100 OHMS

LPI —	Fo
24	22 KC
25	30 KC
26	40 KC
27	52.5 KC
28	70. KC

SLUG TUNED DISCRIMINATORS

Covers the frequency band of 3 kc to 70 kc. Frequency deviation ±8½% of center frequency. ½% linearity. Features slug tuned adjustment. Size 1⅝" x 2¼" x 4½".

FREED # DST	Fo	FREQUENCY DEVIATION	LINEARITY	DC OUTPUT
17	3 KC	± 8½% Fo	WITHIN .5%	32.5V
18	3.9 KC	± 8½% Fo	WITHIN .5%	32.5V
19	5.4 KC	± 8½% Fo	WITHIN .5%	32.5V
20	7.35 KC	± 8½% Fo	WITHIN .5%	32.5V
21	10.5 KC	± 8½% Fo	WITHIN .5%	32.5V
22	12.3 KC	± 8½% Fo	WITHIN .5%	32.5V
23	14.5 KC	± 8½% Fo	WITHIN .5%	32.5V
24	22 KC	± 8½% Fo	WITHIN .5%	32.5V
25	30 KC	± 8½% Fo	WITHIN .5%	32.5V
26	40 KC	± 8½% Fo	WITHIN .5%	32.5V
27	52.5 KC	± 7½% Fo	WITHIN 1%	26V
28	70 KC	±15% Fo	WITHIN 1%	26V
29	22 KC	±15% Fo	WITHIN 1%	26V
30	30 KC	±15% Fo	WITHIN 1%	26V
31	40 KC	±15% Fo	WITHIN 1%	26V
32	52.5 KC	±15% Fo		
33	70 KC	±15% Fo		
		FIXED DISCRIMINATORS		
10	400 cps	±8½% Fo	WITHIN .5%	32.5V
11	560 cps	±8½% Fo	WITHIN .5%	32.5V
12	730 cps	±8½% Fo	WITHIN .5%	32.5V
13	960 cps	±8½% Fo	WITHIN .5%	32.5V
14	1300 cps	±8½% Fo	WITHIN .5%	32.5V
15	1700 cps	±8½% Fo	WITHIN .5%	32.5V
16	2300 cps	±8½% Fo	WITHIN .5%	32.5V

DISCRIMINATOR OUTPUT LOW PASS FILTERS

Covers the frequency range from 6 cycles to 10,000 cycles. Features octal "plug in" header. Size 4" x 6" x 4½".

CHARACTERISTIC IMPEDANCE 330 OHMS
ATTENUATION: LESS THAN .2DB UP TO .5 TIMES Fo
LESS THAN .7DB FROM .5 Fo TO 1. Fo
MORE THAN 20DB AT 2 TIMES Fo
MORE THAN 30 DB FROM 3 TIMES Fo TO 100 KC

LPO —	Fo
9	6 CPS
10	8 CPS
11	11 CPS
12	14 CPS
13	20 CPS
14	25 CPS
15	35 CPS
16	45 CPS
17	60 CPS
18	81 CPS
19	110 CPS
20	160 CPS
21	185 CPS
22	220 CPS
23	330 CPS
24	450 CPS
25	600 CPS
26	660 CPS
27	790 CPS
28	900 CPS
29	1050 CPS
30	1200 CPS
31	1600 CPS
32	2100 CPS
33	7200 CPS
34	10000 CPS
35	

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FREED TRANSFORMER CO., INC.

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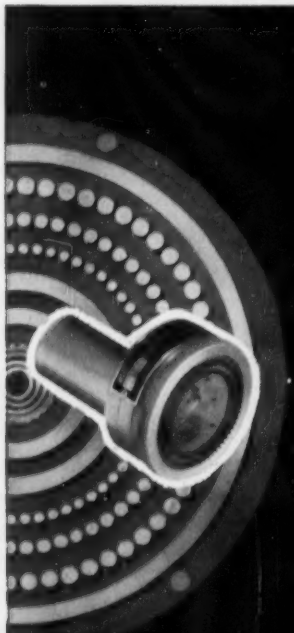
FIRST REPORT

MYCALEX®

TELEMETERING TESTS



1660 hours

of high quality switching at **600 rpm**

March 29, 1955:
After 1660 hours of operation, the new Mycalex Model TM-55 Series Commutator Switch continues to function with a perfect and unchanging signal. This initial continuous test run was halted only to permit a simple brush cleaning — and the life test resumed. Test goal — **10,000 hours!**

170 hours

of uniform operation at **1,800 rpm**

A second test — running concurrently — and using the new Mycalex Model TM-55 Series brush construction provided a clean signal for 170 hours at 1,800 rpm! Once again, operation was halted only to permit brush cleaning — and the test resumed.

Mycalex 410 provides:

- **absolute dimensional and age stability**
- **imperviousness to moisture**
- **precision dimensional tolerance control**
- **temperature endurance to 650°F.**

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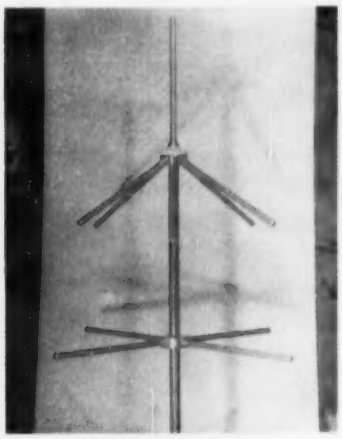
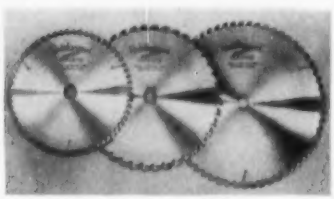
tiometers are especially designed for low-torque, high-function-angle applications. These 2-in., ball-bearing potentiometers are completely enclosed and can be used as single or multiple ganged units. Any practical number of potentiometer sections can be ganged on a single shaft by one-piece stainless-steel clamp rings. This arrangement permits precise phasing of each unit without disassembly and independently of other units.



LOW-BAND ANTENNA
for communications uses

HERB KRECKMAN, 124 Greenwood Drive, Massapequa, N. Y. A new Kreco antenna announced recently is the low-band (25 to 50 mc) duo-ground-plane styled after the tried and proven high-band version. This antenna model GP-830, is ruggedly constructed and easily mounted—and fed with RG-8/U coaxial cable.

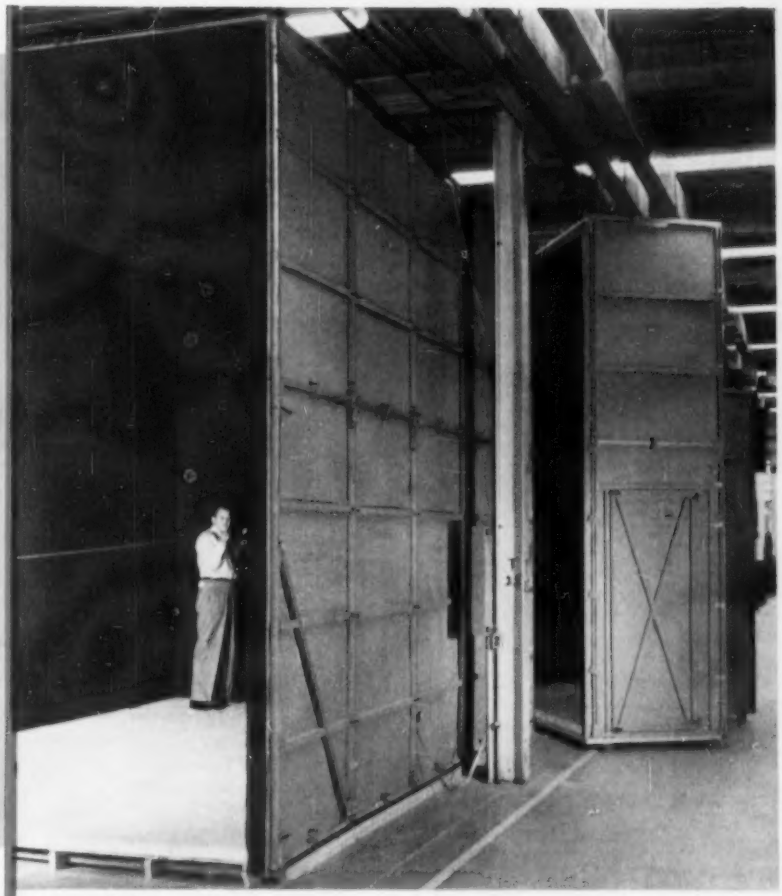


SAW BLADES
are Radialloy-tipped

RADIAL CUTTER MFG. CORP., 831 Bond St., Elizabeth 4, N. J. Extensive field testing in the field of printed circuitry phenolics has enabled the manufacturer to develop a saw that takes naturally to tough

to simulate free space for microwave antenna testing

Westinghouse **uses the new**



McMillan "free space" room

At Westinghouse Electric Corporation's Air Arm Division in Baltimore, the problem was to produce a large room which would simulate free space conditions for microwave testing to be done in conjunction with environmental testing. The McMillan "free space" unit illustrated above was especially designed in association with Westinghouse to fit this particular need.

McMillan supplied a "modular unit" consisting of the individual structural-steel channels, or ribs, together with the microwave absorber panels. It was a simple job for Westinghouse workmen to form the construction and mount the panels.

In this installation, McMillan Hair Mat, type H-4 was used on the wall and ceiling panels for its light weight, while the floor panels utilized McMillan Plastic Foam Block, type B which can be walked on without affecting its electrical performance. All absorbing materials were backed with copper shielding to prevent R.F. disturbance from outside. Panels were approximately 4' x 8'. The complete front section (right hand section of illustration above) which includes the door, was mounted on roller casters to allow large equipment to be moved in and out.

McMillan can produce any size room on this "modular" principle, with whatever type microwave absorber may be required — for either indoor or outdoor use. Send for catalog.

McMillan

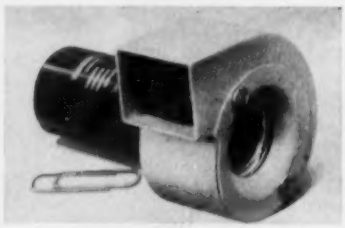
INDUSTRIAL CORPORATION

26 BROWNVILLE AVENUE

IPSWICH, MASSACHUSETTS

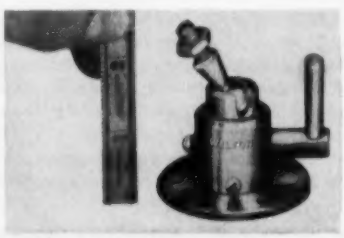
Want more information? Use post card on last page.

cutting materials. The Radialloy-tipped saw blades are ideally suited for application in the electronics industry since they provide fine chip-free cuts, close tolerance operation, smooth edges and production and maintenance economy. They are available in 6, 7, 8, 10, 12, 14, 16 and 18-in. diameters with 30, 40, 60, 72 and 80 teeth. An illustrated brochure is available.



CENTRIFUGAL BLOWER
cools airborne equipment

EASTERN AIR DEVICES, INC., 397 Central Ave., Dover, N. H. A new, compact, high velocity, subminiature centrifugal blower for cooling airborne electronic equipment has been announced. The unit is only 2⅞ in. long and weighs less than 6 oz. Designed and tested for high altitude and high ambient operation, it meets all applicable MIL specifications. The new blower, available in either rotation and in single or double-ended models features a metal blower housing for compactness and maximum air delivery. The housing can be rotated to any required position. These blowers deliver air at comparatively high velocity which is of great importance to efficient cooling of small objects.



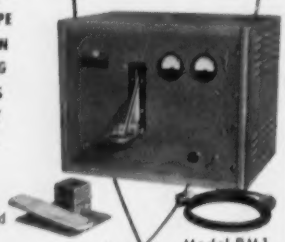
WORK POSITIONER
is small and lightweight

WILLTON TOOL MFG. CO., 9525 Irving Park Road, Schiller Park, Ill. Manufacturers of electronic

marion
advancement in instrument design

SOLDERING PROBLEMS ?

PORTABLE BENCH-TYPE INDUCTION SOLDERING UNIT CUTS ASSEMBLY COSTS...



Simplifies, improves and speeds up component production. Provides local heat to otherwise inaccessible spots. Safe and simple. Max. power input 775 watts, 100 watts standby; 115 volts, 60 cycles. Measures 15⅛" x 21½" x 15", weighs 150 lbs. Price $414.00, foot treadle extra. Complete data on request.

Model PM1

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Grenier Field, Manchester, N. H., U. S. A.
Manufacturers of Ruggedized and "Regular" Panel Instruments and Related Products.
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marion meters

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RESONANT RELAYS
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Q = 50
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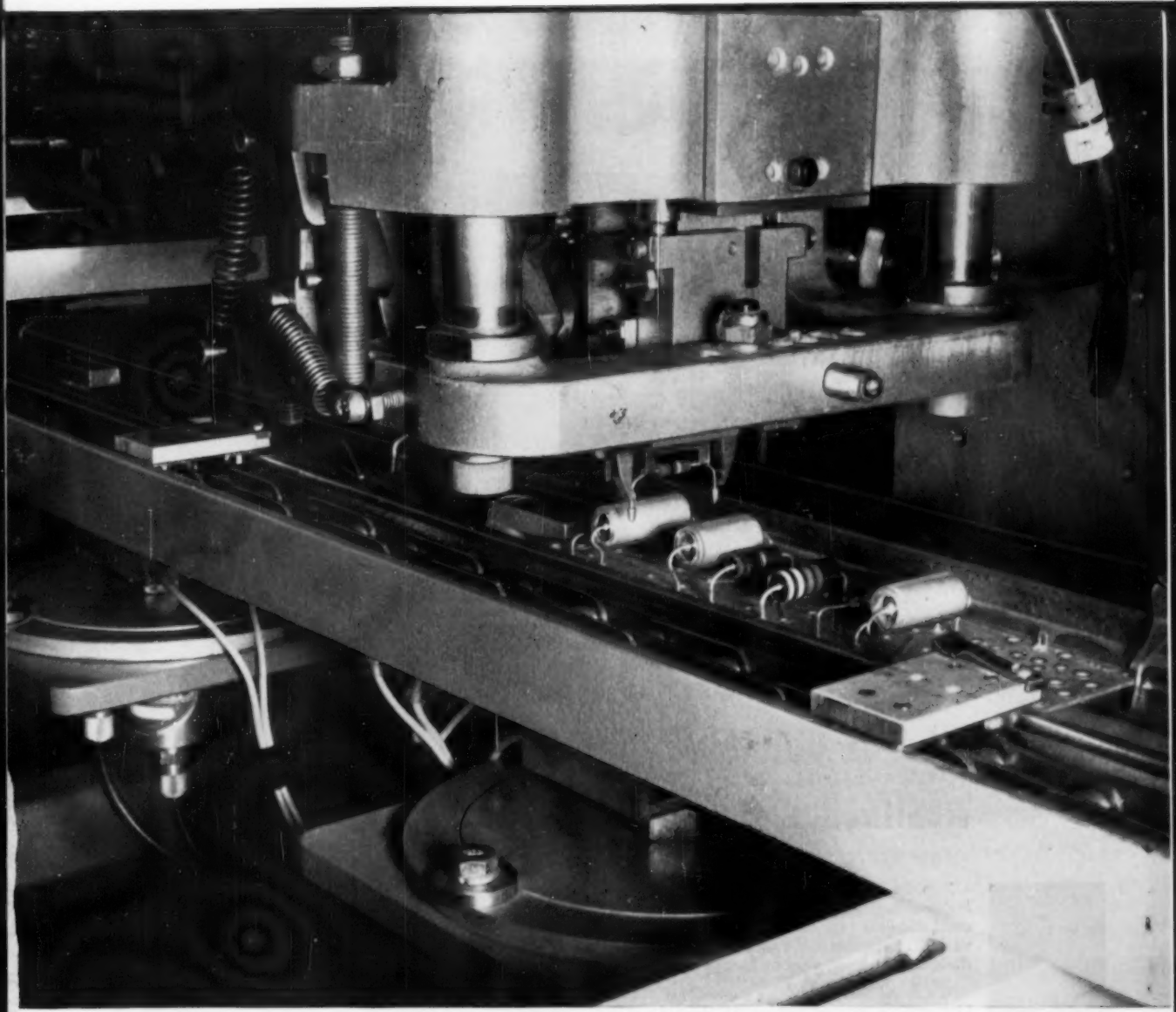

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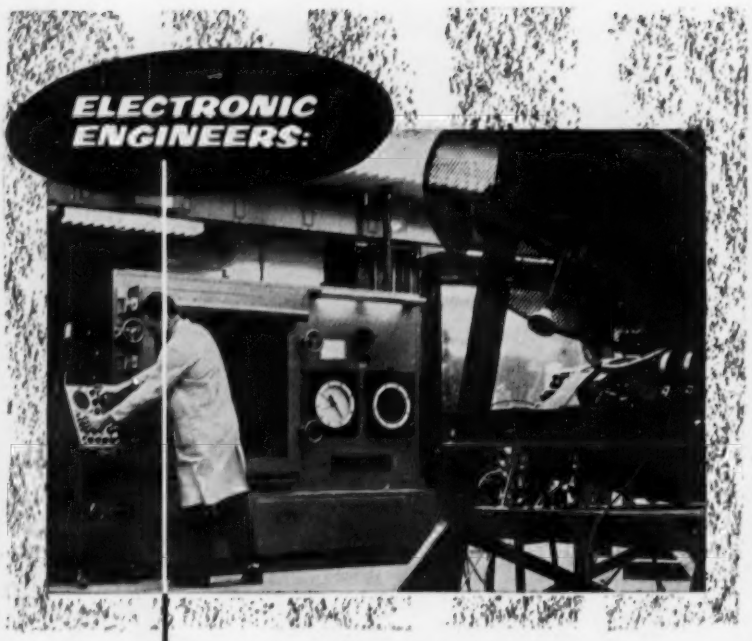
JUST OFF THE PRESS is a new booklet describing the services available to you at the Mechanical Division. An 8-page brochure with details of the *Autofab* machine is also available. For either or both, address Dept. EL-4, Mechanical Division of General Mills, 1620 Central Avenue, Minneapolis 13, Minn.

Job opportunities available for creative engineers. Work closely with outstanding men on interesting projects.

MECHANICAL DIVISION OF General Mills, Inc.



READ WHAT HAPPENED WHEN WE PUT OURSELVES IN THE WESTINGHOUSE TEST CHAMBER

Both the Electronics and the Air Arm Divisions of the Westinghouse Electric Corporation are expanding. We need experienced electronic engineers for advanced design and development work . . . so we put ourselves in the "environmental test chamber" to see just what we have to offer the people we need.

We found that we have a professional atmosphere that is ideal for the engineer. We offer advanced study at company expense and merit promotions that assure a good future.

Our income and benefit advantages scored high on this test, too. Finally, there were many "extras," like the Westinghouse Patent Award Program, that make investigation of the current openings worthwhile for all electronic engineers.

APPLY NOW-

Openings exist in the fields of—

COMMUNICATIONS (Microwave)
FIRE CONTROL
RADAR
COMPUTERS
INDUSTRIAL INDUCTION HEATING
BOMBER DEFENSE
MISSILE GUIDANCE
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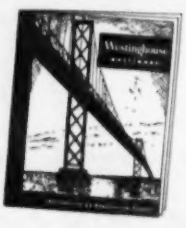
TECHNICAL WRITING
TEST EQUIPMENT

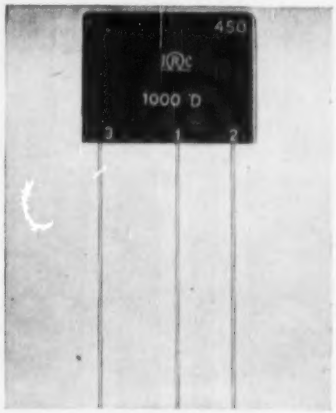
TO APPLY-

Send resume outlining education and experience to:
Technical Director
Dept. 241
Westinghouse Electric Corporation
2519 Wilkens Avenue
Baltimore 3, Md.

ILLUSTRATED BROCHURE WILL BE SENT TO ALL APPLICANTS.



tubes, relays and controls, timing mechanisms and instruments will be interested in the Midget PowR-arm work positioner. It is 2 in. high, weighs ½ lb, and can support 5 lb of work weight at a distance of 3 in. from the swivel center. The device enables a worker to rotate a given work unit freely in all three planes (including right side up and upside down) and to lock it in any desired position merely by moving the control lever. Thus the work piece is always held at the most convenient angle of approach for each operation.



PRINTED CIRCUIT
enclosed by molding process

INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa. Type MCR printed electronic circuit is completely enclosed by a molding process which transforms the entire assembly into a strong, compact unit and features improved moisture resistance and less change on load life. The units offer lower voltage coefficients, greater shelf-life stability and stable, improved temperature coefficients. They are available with round copper wire terminals and tab leads.

GROMMETS
are nonabrasive type

SHAMBAN ENGINEERING CO., 11617 W. Jefferson Blvd., Culver City, Calif. The S11154 one-piece grommets are fabricated of KELON-T (Teflon). Designed for use in aircraft and electronic applications to guide cables and conduits through

TRUFLEX® Thermostat Metal Coils Over ⅛ Mile Long in One Piece Simplify Fabrication and Reduce Costs in Thermal Element Manufacture

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RUGGED
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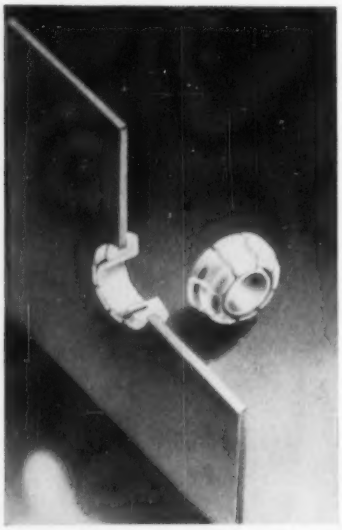
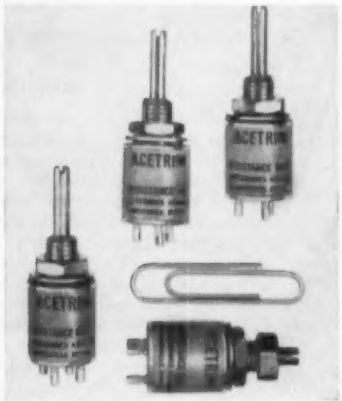
West Coast Mail Address: P.O. Box 3941, North Hollywood, Calif., POplar 5-8620

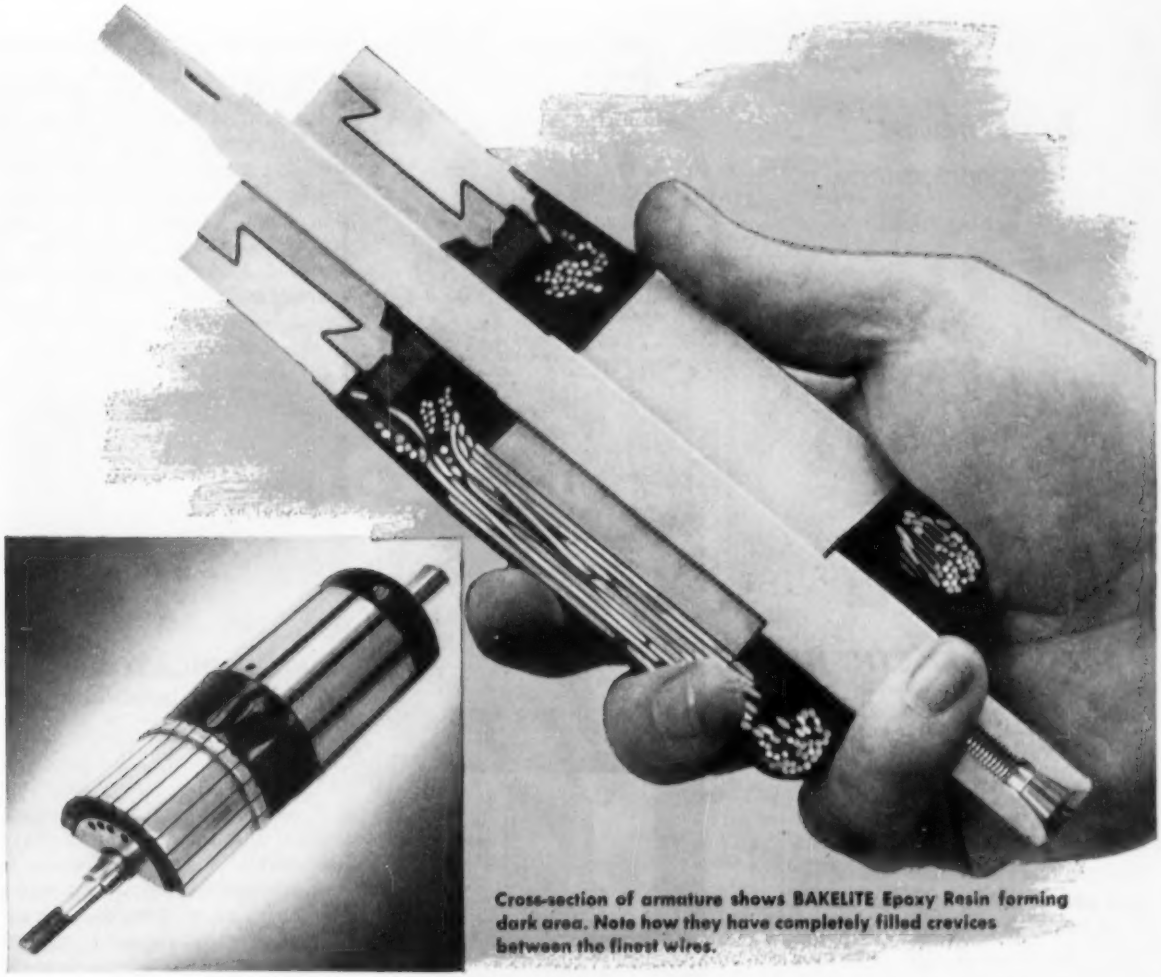


bulkheads, they resist chemical action and heat. Natural slipperiness of KELON-T and smooth rounded edges minimize abrasion and extend service life of cables and conduits. They can be installed easily in blind or hard-to-reach locations from one side of a bulkhead. Useful temperatures range from −110 F to +300 F. Grommets are available in a full range of diameters and will accommodate sheet thicknesses from 0.025 in. to 0.125 in.



TRIMMERS are ½ in. diameter

ACE ELECTRONIC ASSOCIATES, 125 Rogers Ave., Somerville 44, Mass., announces Acetrim, a new line of subminiature wire-wound precision potentiometer trimmers. They feature a diameter of ½ in., resistance range from 10 ohms to 50,000 ohms, ambient temperature range from



Cross-section of armature shows BAKELITE Epoxy Resin forming dark area. Note how they have completely filled crevices between the finest wires.

Encapsulation with BAKELITE Epoxy Resin Ended Rejects and Returns!

With BAKELITE Brand Epoxy Resin replacing conventional materials for insulating this 2 H.P. D.C. motor armature, the manufacturer reports rejects and returns reduced to zero! It is a vital part of a compressor used in special military aircraft and operates at 3,000 psi. and 2 cfm.

The use of BAKELITE Epoxy Resin provided greater permanence of form, higher impact strength, improved chemical and moisture resistance, and lower maintenance cost.

Despite 8000 RPM and temperatures up to 400 deg. F., the manufacturer states that not a single insulation failure has been reported since encapsulation of this armature in BAKELITE Epoxy Resin.

Several types of BAKELITE Epoxy Resins are available for potting and encapsulating techniques. Specially formulated BAKELITE Epoxy hardeners provide a variety of viscosities and curing speeds to meet a wide variety of applications. You can pick the combination with the best set of properties for your specific product. For detailed information and list of suppliers, write Dept. KJ-50.

BAKELITE BRAND EPOXY RESINS

Armature encapsulated by **McCulloch Motors Corp.**, Los Angeles 45, Cal.

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

In the newest computers...

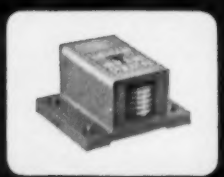
BRUSH MAGNETIC HEADS

help provide system flexibility—accuracy—high storage density

IN DRUM MEMORY SYSTEMS...
Several basic Brush multichannel and single channel heads (and their modifications) permit flexibility in Magnetic Drum design. Low loss materials provide greater magnetic head efficiency.

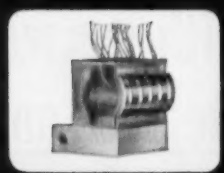
IN TAPE MEMORY SYSTEMS...
Precision construction of Brush multichannel heads with close tolerances on gap and track alignment permits greater pulse packing and closer track spacing. Equipment can be designed with increased storage capacity and faster access with Brush heads

For specifications on standard products or designs to your requirements, write Brush Electronics Company, Dept. K-9A, 3405 Perkins Avenue, Cleveland 14, Ohio.



BK-1300 series—up to 25 interlaced channels per inch.

BK-1500 series—ultimate in precision-made multichannel heads.



BK-1605 series—simple mounting and adjustment, ideal for drum computers.

BK-1501 series—compact, wafer-thin, permit individual adjustment.

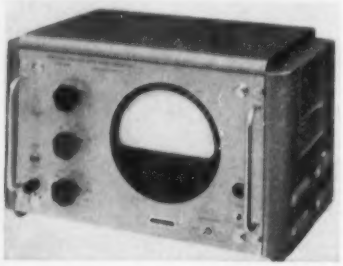
BK-900, BK-1000, BK-1200 series—variety of types for single channel applications.

BRUSH ELECTRONICS COMPANY

Division of Clevite Corporation

BRUSH ELECTRONICS

—55 to 125 C, a new type shaft lock and weight of only ¼ oz. The case and threaded mounting bushing is precision machined, one-piece anodized aluminum for maximum heat dissipation. The shaft is centerless ground stainless steel with a threaded bushing; available with nonrotating lock or stops if required.



VSWR INDICATOR
with 100-cps bandwidth

THE SOLARTRON ELECTRONIC GROUP LTD., Thames Ditton, Surrey, England. Model CA.512 vswr indicator is a compact sensitive amplifying detector unit for use in microwave instrumentation. An indication is given of standing wave direct value, or in terms of ratio or reflection coefficient. The instrument is used in conjunction with a probe detector element which is moved in a slotted-line section of the waveguide under test. Indication is given on a clearly scaled 6-in. meter and there is coarse and fine adjustment of overall sensitivity provided. Due to use of a selective amplifier in the instrument there is an extremely low noise level on the detected signal, this enabling the maximum gain to be used without loss of accuracy in readings.

CONNECTORS
for printed circuits

CANNON ELECTRIC CO., 3207 Humboldt St., Los Angeles 31, Calif., has available five new connectors for

MISSILE TEST EQUIPMENT For over ten years Farnsworth has participated in the design, development, and production of guidance and control systems and special test equipment for such missile programs as Terrier, Talos, Sparrow, and others. Numerous "firsts" in this field have been accomplished as a result of contributions in the form of missile receivers, control systems, power supplies and complete system analyses.

IATRON A charge-controlled cathode ray "memory" tube permits operator-controllable image persistence from one millisecond up to several minutes duration. Unusually brilliant picture presentation at a brightness level of up to 10,000 footlamberts for projection purposes.

IMAGE CONVERTER TUBES Used in any application where it is necessary or desirable to "see in the dark." Convert an infrared image into a visible image. Applications: medical and biological research, hot-body observation, temperature distribution, crime detection, security, and photography.

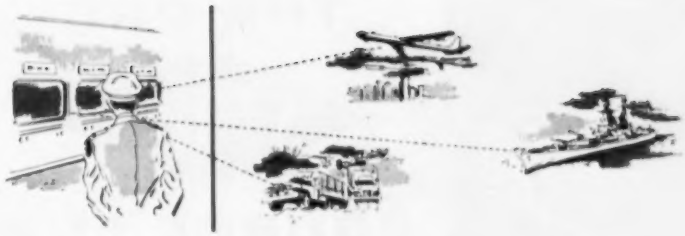
INFRARED VIEWER This unique, compact, easy to handle viewer is a valuable tool for crime detection, research and industrial application. Observation of objects or scenes in the dark is easily accomplished when they are illuminated by infrared radiation.

PHOTOMULTIPLIER TUBES Responsive in the near infrared spectrum featuring sensitivities as high as 50 amperes per lumen of incident radiation. Applications include photometric measurements for industrial and scientific uses.

IMAGE DISSECTOR A highly versatile TV camera tube particularly well adapted for use as a slide or facsimile scanner. This tube can be constructed in a variety of types to meet special requirements.

RADAR RANGE CALIBRATOR, AN/UPM-11A A precision instrument incorporating both "Radar" and "Beacon" functions. The equipment operates as a radar transponder in that pulsed r-f energy fed into the equipment results in a series of return echo pulses being fed back from the equipment to the radar under calibration. This simulates radar targets at accurately determined ranges.

PORTABLE CABLE TESTER Designed for testing all radio frequency cables that will accommodate, or can be adapted to, type "HN", "N", or "BNC" connectors. It will supply a d-c voltage up to 12,000 volts provided the current drain is negligible, and current surges of at least 3,000 amperes peak into a load of 0.05 ohm at room temperature.



MORE THAN 30 YEARS experience in electronic television bring you Farnsworth's model 600A standard Industrial Television system. Military and industrial uses of this great new medium are rapidly becoming common-place but only Farnsworth can offer you this experience plus the skills accumulated over years of successful design and production of complex military electronic equipment. In the air, on the sea, in the factory, in your business—there is a place for industrial television in your future. Why not use the best?

Farnsworth DIVISION OF IT&T

vision . . . beyond the range of sight . . .

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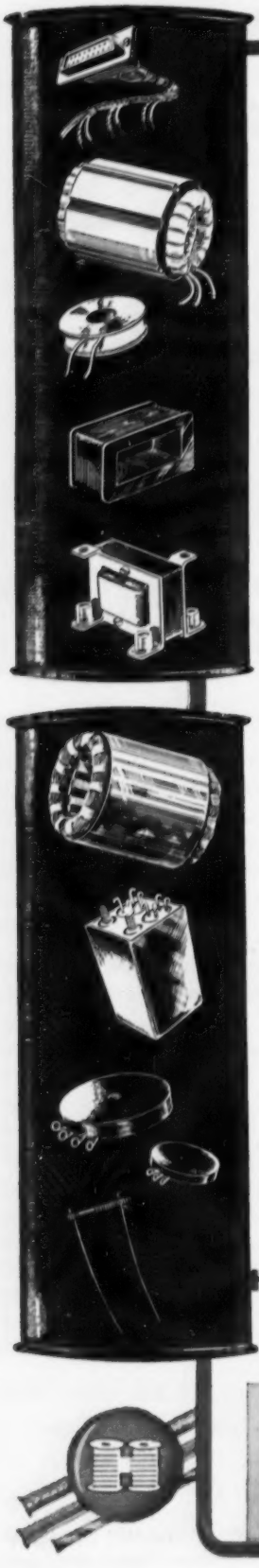

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- "TEMPCLAD", TEFLON INSULATED LEAD WIRE
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- "NEBROC", TEFLON GLASS FIBRE CORD, TAPE AND THREAD
- "TEMPTUBE", TEFLON GLASS FIBRE SLEEVING
- "THERMALON", SILICONE MAGNET WIRE

printed circuits. Ranging from 10, 18, 22, 28 to 44 contacts, these fittings are made of Dupont Zytel molded insulation, with gold plated phosphor-bronze or beryllium-copper contacts. Flashovers are 2,000 v and 2,500 v 60 cps a-c (rms), with a current rating of 5 amperes. Polarization is accomplished by deleting one or more contacts, and inserting a blanking stud in the vacant cavity. Four connector types have single contact rows, one double contact rows. Rivet-and-eyelet type terminals are available.

TURNS RATIO BRIDGE
for lab or production line

SPECIFIC PRODUCTS, 14515 Dickens St., Sherman Oaks, Calif. Model MC-127 turns ratio bridge is now available. An R-C type audio generator and amplifier are used to feed a bridge which has two unknown transformer windings in two legs. The ratio division resistors are in the third leg and balancing decade resistor is in the fourth leg. Output of the bridge is fed to a selective amplifier and to the vtvm which operates the meter. A phasing switch reverses connections to transformer under test which speeds testing operations when used for inspection or production testing. Read-out is direct from decades in turns ratio. A high-low ratio switch changes decimal point on panel. A high-sensitivity switch provides accurate adjustment. Bridge ratio arms are accurate to ± 0.1 percent. Normal operation indicates a single turn in a thousand.

SAPPHIRE BALLS
for insulation purposes

INDUSTRIAL TECTONICS, INC., Ann Arbor, Mich., has available a series

Here's the Complete "Package"

for Counting Electrically...

Added Evidence that —

Everyone Can Count on VEEDER-ROOT

This Veeder-Root Reset Magnetic Counter (AC or DC) is actuated through electromagnets. And it may be connected in series with any device having a contact arrangement . . . like the specially designed Veeder-Root Electrical Contactor at the left, which insures positive operation of the counter, either in oscillation or connected directly to a revolving shaft . . . with the counter placed at *any* distance from the machine or process on which the count is required.

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Design of special transformers and reactors.

Send complete resume to: Manager, Engineering Personnel

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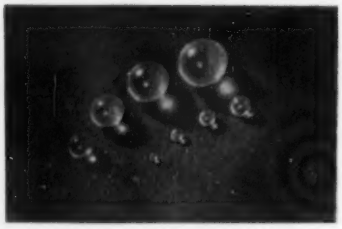
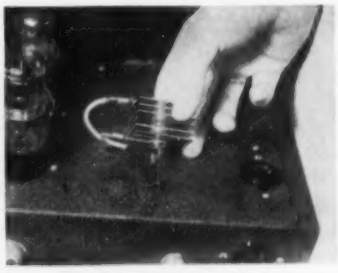


of precision synthetic sapphire balls ranging in size from $\frac{1}{64}$ in. to $\frac{1}{8}$ in. diameter. Specific gravity is 3.98; melting point, 2,030 C; water absorption, zero; and compressive strength, 300,000 psi. These sapphire balls may be used in bearings to insulate the inner race from the outer race; in relays, where a rolling contact utilizes the hardness and insulating properties of the material; and in variable capacitors to insulate the rotor from the stator.



SNAP-IN RECTIFIER
speeds assembly time

RADIO RECEPTOR CO., 240 Wythe Ave., Brooklyn, N. Y., has announced a new snap-in type rectifier featuring a clip arrangement which does not require tools for assembly, speeds assembly time and completely eliminates broken studs. Known as a Qui-klip, it does not require special sockets for mounting, only needing two round holes to be snapped into place. In addition, solderless connectors are available for making electrical contact to the rectifier.

INDUCTORS
for r-f transmission uses

ILLUMITRONIC ENGINEERING, 680 E. Taylor, Sunnyvale, Calif. Two new design features incorporated into the construction of Air Dux inductors give them greater adaptability in meeting the engineering demands

There's always INSTRUMENT News from

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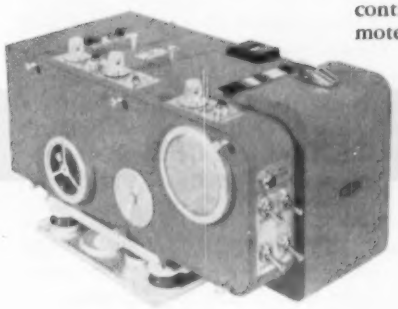
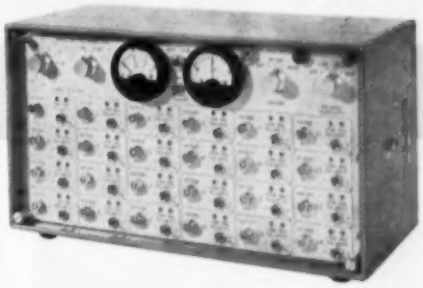
MI 590 OSCILLOGRAPH — SPECIALLY DESIGNED FOR REMOTE CONTROL

Every feature necessary for successful use as a flight-test instrument. This new design incorporates all the rugged dependability of previous models *plus* new features which provide possibilities for controlling the oscillograph from a remote location.



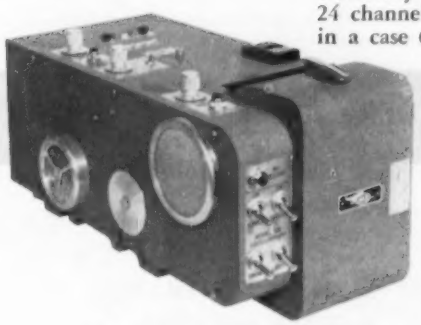
MI 580 OSCILLOGRAPH — DEPENDABLE FOR FLIGHT-TEST . . . FIELD . . . OR LABORATORY

This model provides 14 channels of separate data, observable on full-width viewing screen while in operation, and recorded at selected speeds ranging from ½ to 44¾ inches per second. Designed for flight-testing, field or laboratory applications.



MI 435 BRIDGE BALANCE UNIT VERY SMALL . . . VERY VERSATILE

The use of miniature precision components and rugged, aluminum alloy case combine to produce a general purpose instrument for laboratory or flight-test use. The smallest possible size, with versatility of operation and application; 24 channels, plus automatic calibration, in a case 6″ x 11″ x 5-11/16″.



MI 581 OSCILLOGRAPH — EXTREMELY VERSATILE FOR USE UNDER MOST RUGGED CONDITIONS

Similar to the 580 in basic design, this model includes many extra features with only a minimum increase in size. It also contains a No-Record Indicator, Burn-Out Indicators, Automatic Record Numbering, Captive Fasteners, and Automatic Record-Length Control.

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MIDWESTERN INSTRUMENTS

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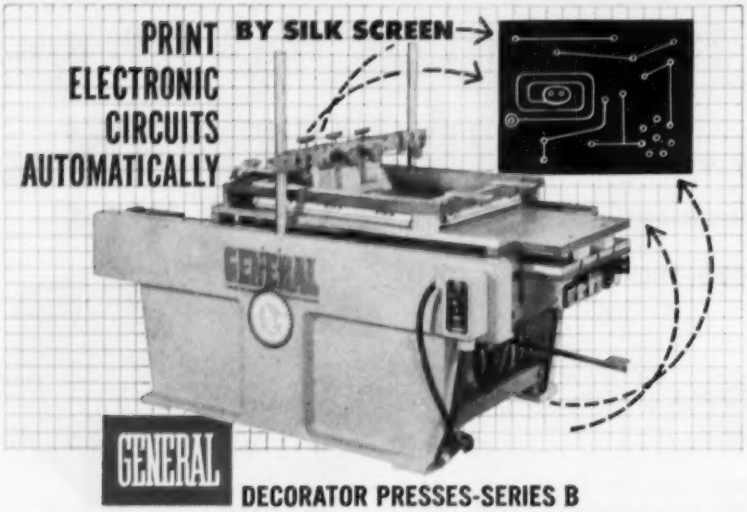
TULSA, OKLAHOMA

MIDWESTERN MI INSTRUMENTS



GENERAL **DECORATOR PRESSES-SERIES B**

■ The Silk Screen method is being widely accepted for preparing copper laminated plastic panels prior to etching printed circuits. General Decorator Presses put printed circuits on an automatic, high production basis. Bowed panels are held flat by vacuum. Line contact impression and accurate register give clean, sharp reproduction of fine lines. Controlled inking lays down a thick, uniform layer of resist.

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Sheet Size	13x25"	19x25"	19x37"
Speeds Up To	1500 per hr.	1500 per hr.	1500 per hr.

ThermoJet DRYER Utilizes a new system for high speed drying of inks, resists and coatings by greatly accelerated evaporation of solvents.

GENERAL

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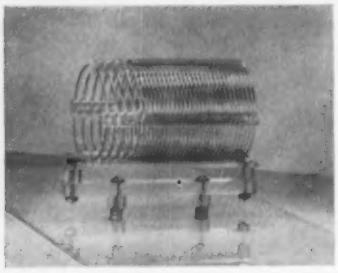
In this new broadband linear, Central Electronics, Inc., unveils several major advances. And for the meter proper C.E. chooses Burlington. Why Burlington? First, because they combine quality with a reasonable price. Second, because they offer an illuminated instrument that can be re-lamped from the front. Wherever and however you use electrical instruments, you'll probably find *your* best answer in Burlington stock or custom-made instruments.

Write for Catalog N1

BURLINGTON INSTRUMENT CO.
127 N. Third St. Burlington, Iowa

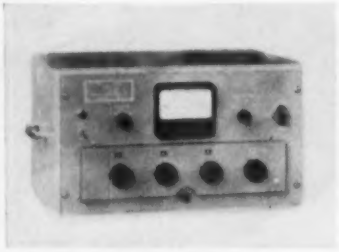
Burlington
CUSTOM BUILT TO SPECIFICATION



of r-f transmission equipment. Air Dux coils may be made with a change in the pitch of the winding for higher Q's, also indenting of alternate turns may be utilized for greater ease of tapping. The coils are manufactured in various diameters from fractions of an inch to several feet. They can be wound in any pitch, with any wire size and finish, and with several available mounting methods, to meet the varied needs of the manufacturer.

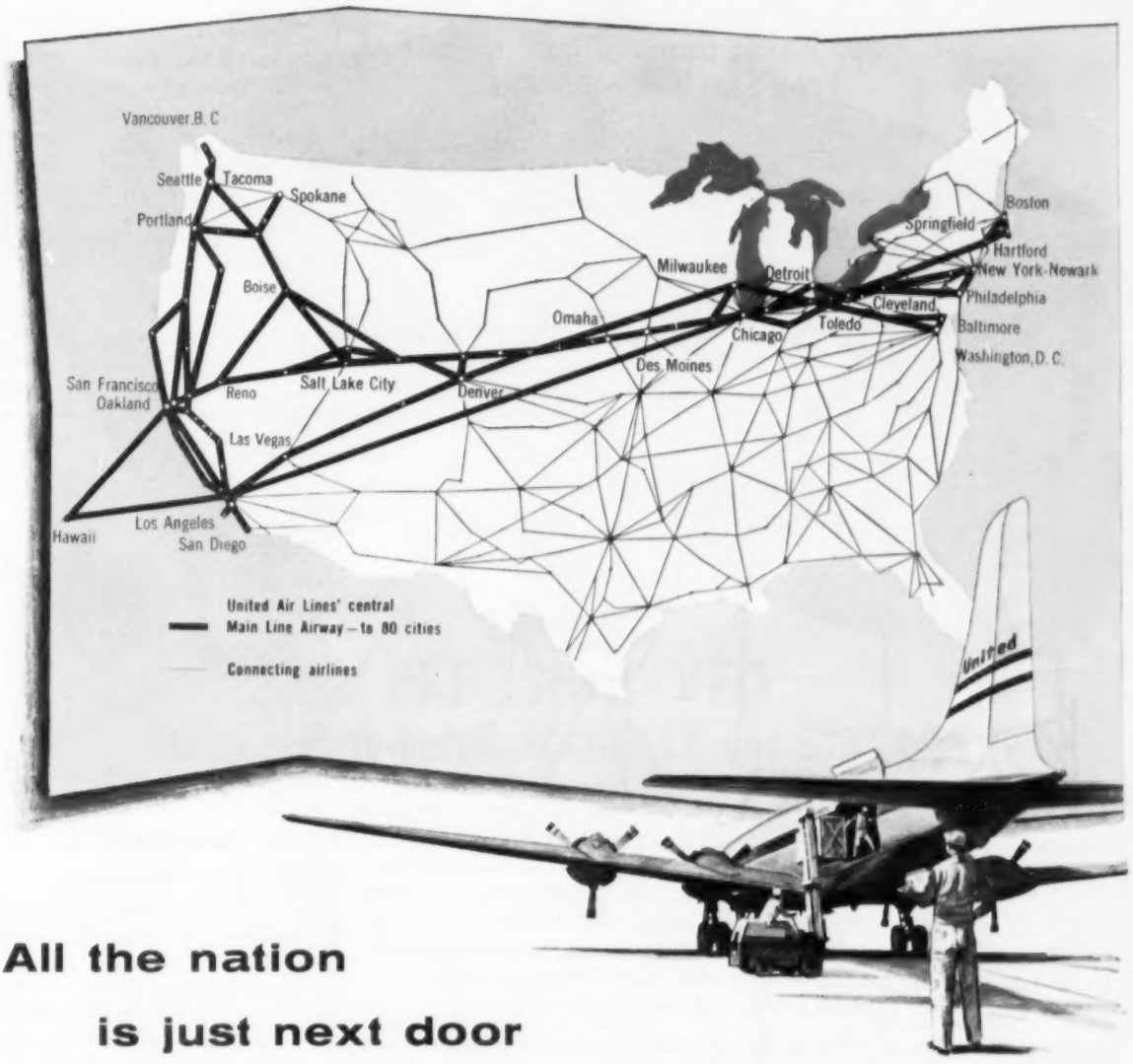
RECEIVER TUBES
straight-sided button-stem

GENERAL ELECTRIC CO., Schenectady 5, N. Y. Straight-sided button-stem versions of two receiving type tubes have been added to the company's line. The 5R4-GYA retains the same electrical characteristics as the 5R4-GY. However, in the T-12 size bulb, the new tube is half an inch smaller in diameter than the ST-16 glass type bulb. The new 6L6-GB is about ¾ in. shorter and ¼ in. smaller in diameter than the 6L6-GA and considerably smaller than the 6L6-G. Here also electrical characteristics remain the same.



SIGNAL GENERATOR
is crystal controlled

DECADE INSTRUMENT CO., Box 153, Caldwell, N. J., has announced the Decalator model 100, a new crystal controlled signal generator from



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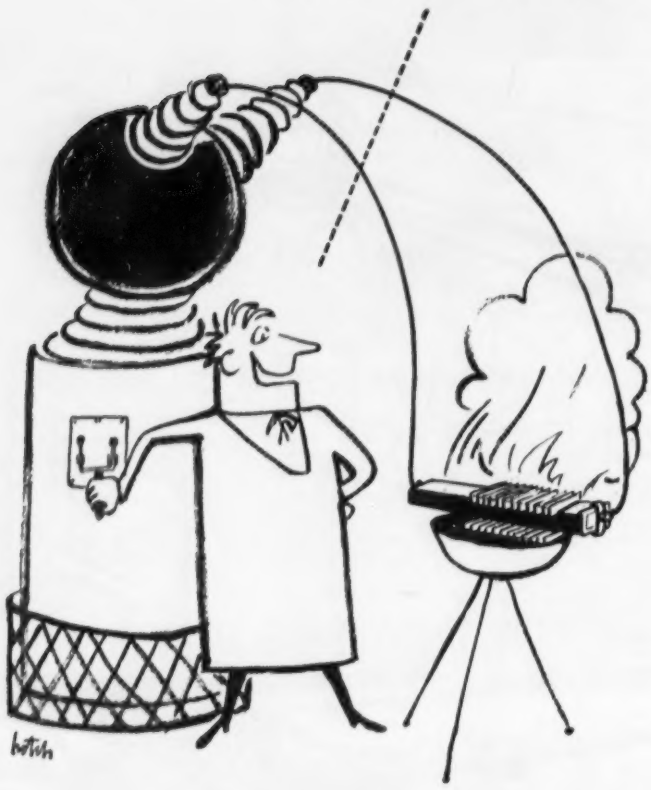
"so Narda terminations
can't be burned out, eh?"



Of course, we mean *microwave* power. That's our statement: within their designed frequencies, we don't know anyone who has enough microwave power available to affect our line of terminations.

People have tried, too! One correspondent tells us that he overloaded our Model 320 by 100%, putting 1000 watts average power into this termination which we rate at 500.

Made of aluminum with fins for effective heat dissipation, these high power terminations cover the entire waveguide band with an average VSWR of only 1.05. Standard cover flanges are provided. Narda terminations may be pressurized for increased peak ratings.

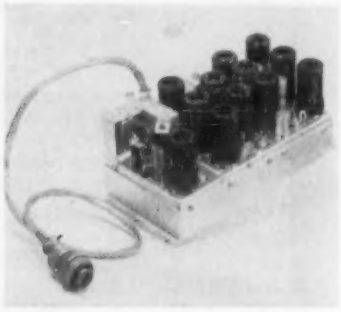
Write for our catalog describing the complete line of Narda microwave and uhf test equipment. We also like to apply our skills and considerable experience to unusual problems in microwave and uhf. Give us a call if you have a problem.

the narda corporation

160 HERRICKS RD., MINEOLA, N. Y. • PIONEER 6-4650

COMPLETE INSTRUMENTATION FOR MICROWAVE AND UHF

10 kc to 1.5 mc. Features include decade switching for rapid selection of desired frequency and perfect resettability, multiscale meter and attenuator for wide-range output voltage, extremely high accuracy, dependability and ease of operation. Specifications include: steps, 1 kc in 3 decades; interpolation, calibrated 0 to 1 kc; accuracy, 100 cps; short term stability, ±25 cps; harmonic content, 3 percent maximum; output, 3 v rms; attenuator, 3 v, 1 v, 0.3 v, 0.1 v, 0.03 v, 0.01 v full scale; meter, calibrated 0 to 1 and 0 to 3 v. Price is $995.



DATA TRANSMITTER
for telemetering systems

WEST COAST ELECTRONICS CO., 5873 W. Jefferson, Los Angeles, Calif. Model XT-1 telemetering transmitter is designed for higher powered data transmission in guided missile and aircraft telemetering systems. It accepts modulating signals between 900 and 100,000 cycles. It provides 8-w power output; 215 to 235-mc frequency range; direct crystal control with a precision better than 0.03 percent; 50-ohm output impedance; 150-kc deviation, frequency modulation; frequency response flat within ±1 db; less than 1 percent harmonic distortion; 50,000 ohms video input impedance. A bulletin giving further specifications, a typical application block diagram, and outline and mounting dimensions is available.

TRANSFORMER KIT
aids pulse circuit design

SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass. Pulse transformer kit, catalog No. 100Z1,

Collins PRECISION VFO—
Ready-to-Install ACCURACY and STABILITY

Accuracy and stability — the two most important features in Oscillator performance — can now easily be incorporated into your high-performance design, cutting engineering time to a minimum. Whether your project is a transmitter, receiver, test equipment, frequency standard or others, Collins offers a ready-to-install Variable Frequency Oscillator known for its linear calibration and stable output.

- Outstanding Stability
  - Average 24-hour stability under fixed-station conditions .003% or better.
  - Single-knob tuning with backlash of less than one cycle in 20 kc through use of mechanical loading and precision ballbearing construction.
  - Frequency modulation less than 100 cps under 5 G's acceleration at 60 cycles.
- Compact, ready-to-operate design.
- Linearity of calibration better than 1 kc throughout tuning range with multiple-turn tuning.
- Sealed against atmospheric changes.
- Available in fundamental ranges from 300 kc to 4 mc. Individual models achieve up to 2 to 1 tuning ratio.
- Uses standard power supply voltages.
- Each unit 100% tested under lab conditions to rigid specifications.
- Ease of installation.

Frequency Ranges Available

70E-1	1.0-1.5 mc
70E-10	600-800 kc
70E-12	1.955-2.955 mc
70E-15	2.0-3.0 mc
70E-20	1.65-2.05 mc
70E-21	300-400 kc
70E-25	2.0-4.0 mc
70H-2	2.455-3.455 mc
70H-3	1.5-3.0 mc

For requirements other than the above ranges or for detailed specifications write to the Collins office nearest you

COLLINS RADIO COMPANY CEDAR RAPIDS, IOWA

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1930 Hi-Line Drive, DALLAS 2, TEXAS
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COLLINS RADIO COMPANY OF CANADA, LTD.
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COLLINS

PRECISION ATTENUATION TO 3000 mc!

Protected under Stoddart Patents

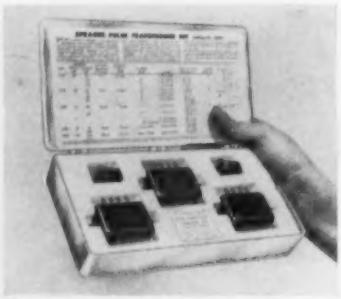
six-position
TURRET ATTENUATOR
featuring **PULL-TURN-PUSH** *action*

FREQUENCY RANGE: dc to 3000 mc.
CHARACTERISTIC IMPEDANCE: 50 ohms.
CONNECTORS: Type "N" Coaxial female fittings each end.
AVAILABLE ATTENUATION: Any value from 1 db to 60 db.
VSWR: 1.2 max., dc to 3000 mc/s, values from 10 to 60 db. As value decreases below 10 db, VSWR increases to not over 1.5.
ACCURACY: ± 0.5 db.
POWER RATING: One watt sine wave power dissipation.

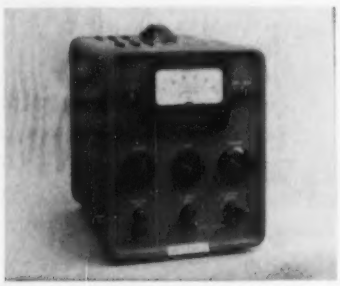
SINGLE "IN-THE-LINE" ATTENUATOR PADS and 50 ohm COAXIAL TERMINATIONS

This new group of pads and terminations features the popular Type C and Type N connectors, and permits any conceivable combination of the two styles. For example, the two connector types, either male or female, can be mounted on the same attenuator pad, with or without flanges, so that it may serve as an adapter as well as an attenuator. Frequency range, impedance, attenuation, VSWR, accuracy and power rating are as designated above. Send for free bulletin entitled "Measurement of RF Attenuation."

STODDART AIRCRAFT RADIO Co., Inc.
6644-A Santa Monica Blvd., Hollywood 38, California · Hollywood 4-9294

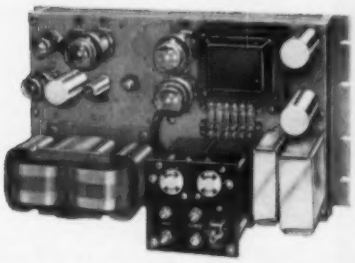


contains 5 laboratory-type pulse transformers especially chosen to cover a wide range of practical applications, with primary inductance values from 0.5 mh to 50 mh, and turns ratios as high as 8 to 1. Each miniature transformer has multiple windings, permitting the engineer to easily select the characteristics best suited to his application—whether in push-pull driving, blocking oscillator, pulse gating, pulse amplifier or impedance matching circuits.

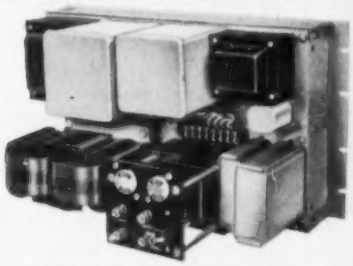


D-C SUPPLY
with high resolution

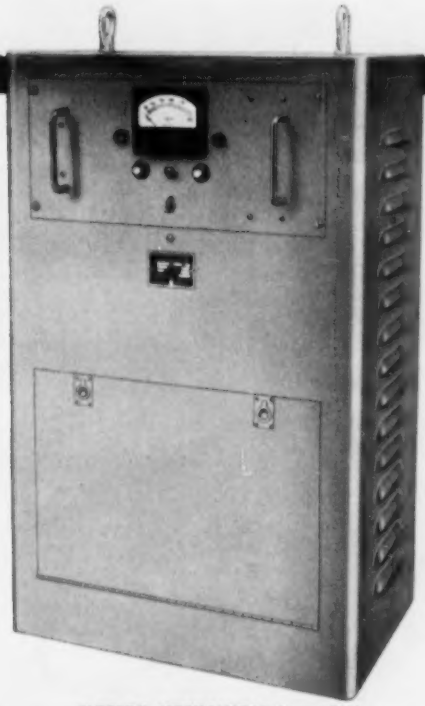
JOHN FLUKE MFG. CO., INC., 1111 W. Nickerson St., Seattle 99, Wash. Designed for instrument calibration work, the model 406 high resolution d-c supply has excellent stability. Coarse, fine and vernier output controls permit setting the output to within 2 mv of the value desired over the entire 530-v range. Regulation against 20-percent line voltage change or 100-ma load change is 0.01 percent or 50 mv. Ripple is less than 1 mv and short-term stability is better than 0.01 percent. Auxiliary outputs are 0 to 225 v bias and 6.3 v, 3 amperes a-c. Precision wire-wound resistors are used throughout in sampling circuits and at critical points. The compact, portable unit has an illuminated 4½-in. meter selectively switched to



INSTANTANEOUS ELECTRONIC (type IE)
For instantaneous correction and extremely close control. Completely electronic. No moving parts.



TUBELESS MAGNETIC (type TM)
For unattended locations and critical uses where tube failure cannot be tolerated.



ELECTRO MECHANICAL (type EM)
For large industrial loads or for applications requiring zero waveform distortion and high efficiency.

STABILINE AUTOMATIC VOLTAGE REGULATORS

Designed to Maintain Root Mean Square Voltage

Here is a complete line of automatic voltage regulators designed with the application in mind . . . with *operating* characteristics that *always* equal or better the nameplate rating.

Of special importance is the fact that STABILINE maintains the root mean square voltage — the voltage rating for which all electrical equipment is designed. Before you purchase automatic voltage regulation equipment, make sure it is R.M.S. responsive.

We have detailed information about STABILINE automatic voltage regulators. Send the coupon for your copy of our Bulletin S351.

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FOR OUR COMPLETE PRODUCT LINE... SEE electronics '55 BUYERS' GUIDE pp. 302-303

THE SUPERIOR ELECTRIC COMPANY

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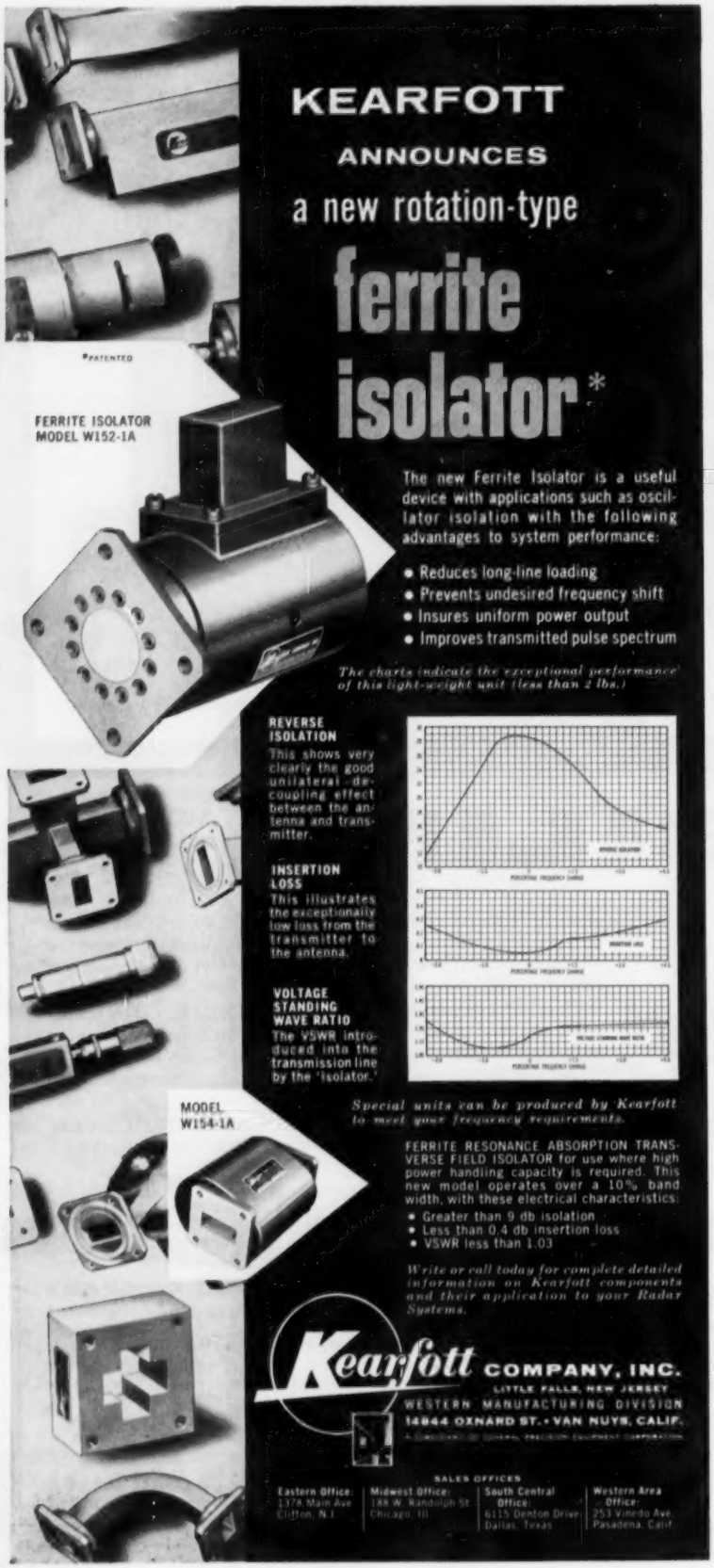
KEARFOTT
ANNOUNCES
a new rotation-type
ferrite
isolator*
*PATENTED
FERRITE ISOLATOR
MODEL W152-1A
The new Ferrite Isolator is a useful device with applications such as oscillator isolation with the following advantages to system performance:
• Reduces long-line loading
• Prevents undesired frequency shift
• Insures uniform power output
• Improves transmitted pulse spectrum
The charts indicate the exceptional performance of this light-weight unit (less than 2 lbs.)
REVERSE ISOLATION
This shows very clearly the good unilateral decoupling effect between the antenna and transmitter.
INSERTION LOSS
This illustrates the exceptionally low loss from the transmitter to the antenna.
VOLTAGE STANDING WAVE RATIO
The VSWR introduced into the transmission line by the 'isolator.'
Special units can be produced by Kearfott to meet your frequency requirements.
MODEL W154-1A
FERRITE RESONANCE ABSORPTION TRANSVERSE FIELD ISOLATOR for use where high power handling capacity is required. This new model operates over a 10% band width, with these electrical characteristics:
• Greater than 9 db isolation
• Less than 0.4 db insertion loss
• VSWR less than 1.03
Write or call today for complete detailed information on Kearfott components and their application to your Radar Systems.
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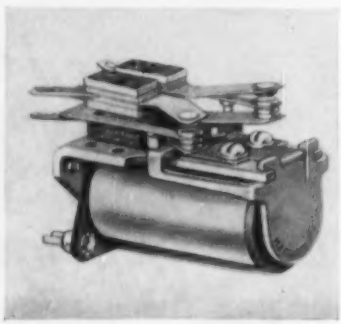
Midwest Office: 188 W. Randolph St. Chicago, Ill.
South Central Office: 6115 Denton Drive Dallas, Texas
Western Area Office: 253 Vinedo Ave Pasadena, Calif

read output current, output voltage and bias voltage.

MOTOR GENERATOR
is subminiature type

JOHN OSTER MFG. CO., 1 Main St., Racine, Wisc. Type MG301 3 motor generator measures only 1 in. o-d by 2.625 in. long and weighs 6.2 oz. Output is 1.25 v per 100 rpm when operated into a load of 100,000 ohms. Speed is continuously variable for 200 to 8,700 rpm. The output remains completely linear over the entire speed range. Harmonic distortion is under 5 percent. Magnetic detent stops the output shaft in any of 4 positions within 5 deg accuracy. The motor is a 115 v, 400-cycle, 2-phase drive motor with a stall torque of 0.15 oz-in.



POWER RELAY
is a miniature type

MAGNECRAFT ELECTRIC CO., 3350 W. Grand Ave., Chicago 51, Ill. Switching of heavy currents up to 10 amperes and high operating sensitivity are combined in a new miniature power relay. The new heavy current contacts can be furnished in combination with bifurcated contacts for switching both heavy loads and low level signal loads with the same relay. Coil and contact terminals at mounting end of the relay facilitate concealed wiring of either

AVAILABLE NOW!

NEW HUDSON STANDARD CASES

STANDARD RECTANGULAR SIZES

HU—764:
DIMEN. A—63/64"
DIMEN. B—1 57/64"
LENGTH—3"

HU—769:
DIMEN. A—2 5/16"
DIMEN. B—6 15/16"
LENGTH—3 3/32"

HU—770:
DIMEN. A—2 33/64"
DIMEN. B—4 9/32"
LENGTH—3 11/32"

HU—783:
DIMEN. A—⅝"
DIMEN. B—1 5/16"
LENGTH—1 7/16"

HU—788:
DIMEN. A—1 5/32"
DIMEN. B—1 13/32"
LENGTH—⅞"

HU—791:
DIMEN. A—2 19/64"
DIMEN. B—2 13/16"
LENGTH—1 43/64"

HU—797:
DIMEN. A—1 7/16"
DIMEN. B—2"
LENGTH—2½"

HU—799:
DIMEN. A—27/32"
DIMEN. B—1 25/64"
LENGTH—1 47/64"

STANDARD ROUND SIZES

HU—695:
OUTSIDE DIA.—2 15/32"
LENGTH—6"

HU—707:
OUTSIDE DIA.—1 29/64"
LENGTH—1⅛"

HU—721:
OUTSIDE DIA.—1 61/64"
LENGTH—2⅝"

HU—749:
OUTSIDE DIA.—1 19/64"
LENGTH—3"

HU—757:
OUTSIDE DIA.—1⅞"
LENGTH—2½"

HU—787:
OUTSIDE DIA.—1 41/64"
LENGTH—3⅛"

HU—798:
OUTSIDE DIA.—2 25/32"
LENGTH—5½"

HU—803:
OUTSIDE DIA.—1 1/16"
LENGTH—2½"

STANDARD SQUARE SIZES

HU—692:
DIMEN. A—1⅞"
LENGTH—3 3/16"

HU—723:
DIMEN. A—1 17/64"
LENGTH—1"

HU—737:
DIMEN. A—1 5/16"
LENGTH—1⅞"

HU—768:
DIMEN. A—1½"
LENGTH—3½"

HU—781:
DIMEN. A—45/64"
LENGTH—1⅜"

HU—785:
DIMEN. A—1 1/64"
LENGTH—2"

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Offering the Most Complete Line of Precision Drawn Cases and Covers in the Industry!

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HUDSON TOOL & DIE COMPANY • INC
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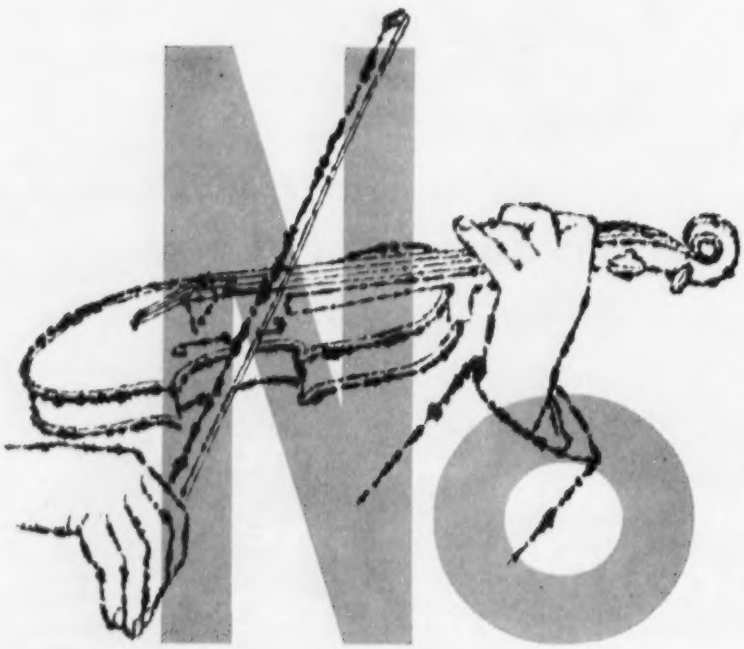


violin music

The demand exceeds the supply. It's that simple!

With 3 engineering jobs available for every 2 engineers, some 5,000 companies are bidding for you with offers, inducements and background music. But don't be mistaken! Most of today's "opportunities" are *jobs*, not futures.

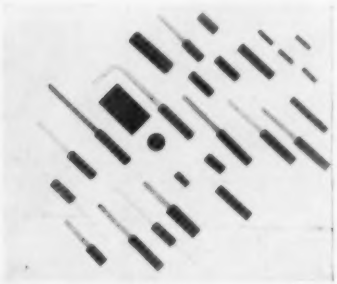
We, too, want engineers. But we're offering no violin music—only the opportunity for intelligent and careful evaluation—you of us and we of you—with the possibility of your joining one of the finest team operations in the whole new world of flight systems development.

Most of the people on that team are young, and moving ahead fast. They weren't lured here. They found out—and figured out—for themselves. We hope you'll do that too.

Write to J. M. Hollyday, Dept. E-9, The Glenn L. Martin Company, Baltimore 3, Maryland.

MARTIN
BALTIMORE · MARYLAND

individually mounted or strip mounted relays. Contact combinations up to 4pdt can be furnished, also hermetically sealed or dust tight enclosure.



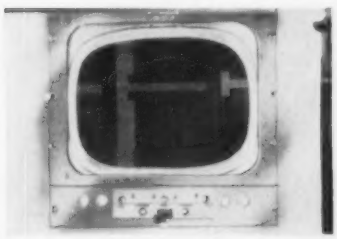
FERRITE CORES
in assorted types

SUPEREX ELECTRONICS CORP., 4-6 Radford Pl., Yonkers, N. Y., has announced an assortment of 27 representative ferrite cores for engineers and designers. The cores included vary from flat stick cores, to disks, pigtail cores, standard studded cores; spaghetti cores, as well as other types listed. Price of the kit is $2.25.

UHF THERMOCOUPLES
range from 5 ma upwards

BEAM INSTRUMENTS CORP., 350 5th Ave., New York, N. Y. A number of uhf thermocouples, ranging from 5 ma upwards, have been added to the standard line. They are extremely small in size featuring both minimum capacitance and inductance. The thermocouples are electrically insulated from the heaters and tested to 100 v d-c. Resistance tolerances for heater or thermocouple are ±10 percent. Nominal output is 7 mv. Current ratings can be exceeded by a 50-percent overload for long periods of time without risk or damage to the thermo-

couple; heaters will withstand transient overloads of 100 percent. Overall temperature coefficient does not exceed 0.2 percent. Dimensions do not exceed $\frac{5}{8}$ in. approximately. Close electrical consistency is maintained.



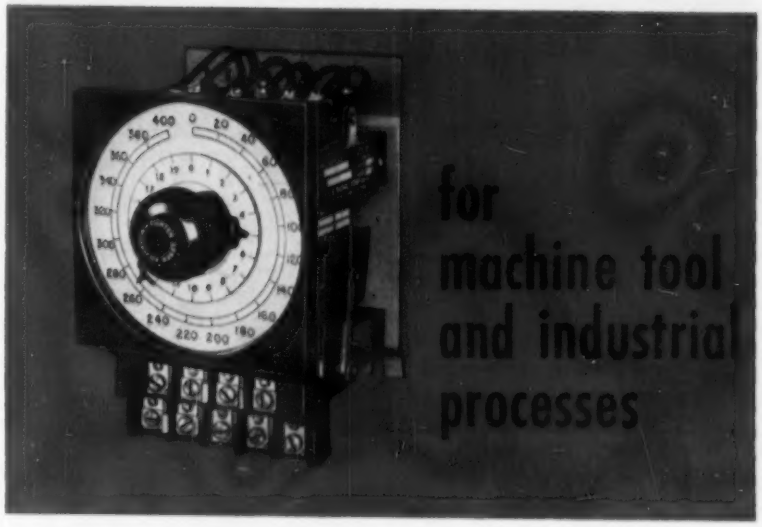
PULSE MONITOR
for tv broadcasting

TELEVISION UTILITIES CORP., 1315 Jericho Turnpike, New Hyde Park, L. I., N. Y., has announced a new Private Eye pulse cross monitor, designed for color or monochrome broadcasting, for use in master control rooms and remote studios. It checks the number of equalizing pulses, sync generator waveforms including front to back porch, remote and local sync, and provides a continuous check on operation even with Genlock types of sync generator locking devices. The pulse cross visually displays the number and width (in microseconds) of all pulses contained in standard composite RETMA video signals.

JUNCTION TRANSISTOR
for low-power audio uses

RADIO CORP. OF AMERICA, Harrison, N. J. The 2N77 is a germanium alloy junction transistor of the *pnp* type designed especially for a-f amplifier service in hearing-aid ap-

EAGLE
Microflex reset counter



makes shutdown and feed-down automatic

Convert machine tool and industrial processes from manual to automatic operation — with this Microflex Reset Counter. For example, use it to feed a grinding wheel down after a preset number of operations. Or employ it to shut down a machine at the desired number of operations. This reset counter is ideal for controlling chemical feeding processes by shutting down a pump after the desired number of operations.

The Microflex Reset Counter is actuated by a series of electrical impulses. Models are available with 400 and 1000 count dials. Dial settings easy to make — counting range from 1 to 400 in steps of 1 with 100% accuracy. On 1000 count range, dial settings are in steps of 1 with accuracy of ± 1 count. Spring reset in less than 1 second.

MAIL COUPON TODAY

EAGLE SIGNAL CORPORATION
Industrial Timers Division, Dept. E-955
MOLINE, ILLINOIS

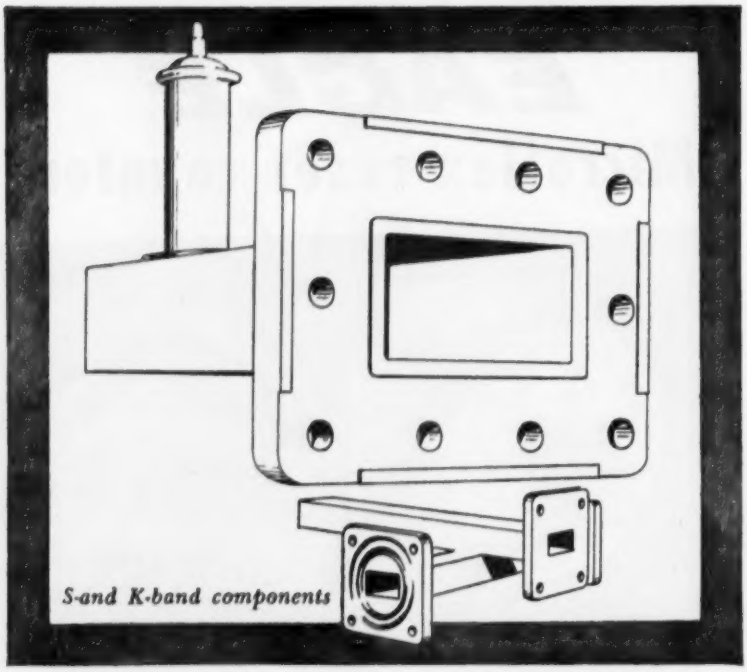
Please send free Bulletin 720 containing full data on Microflex Reset Counter.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE



S-and K-band components

how small can a wave guide get?

Well, alongside some of the stuff we're working with now, the radar plumbing we used during World War II gets to look like air-conditioning duct. What's more, some of our boys here seem to regard anything below S-band as practically pure D.C. Naturally, we're up to our hips as usual in work on military equipment. However, we do occasionally have some extra creative capacity available, so if you have a problem involving something special in wave guide components (real small ones, too) and like that, maybe we can help. Drop us a line.

L. H. TERPENING COMPANY

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Microwave Transmission Lines and Associated Components

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plications. The transistor is hermetically sealed, utilizes an insulated metal envelope, and has flexible leads which may be soldered or welded into the associated circuits. It measures 0.240 in. in diameter and has a maximum length (excluding flexible leads) of 0.405 in. The 2N77 features an average noise factor of 6.5 db, a matched-impedance, l-f power gain of 44 db, and a collector-to-emitter alpha frequency cutoff of 700 kc.

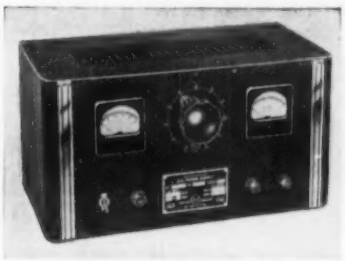
COAXIAL CABLE
features low capacitance

MICRODOT, 1826 Fremont Ave., South Pasadena, Calif., has announced new coaxial cable types designated 93-3913 and 93-3914. With capacitance of just 12 $\mu\mu$f per ft, the o-d of the cables is held to 0.132 in. maximum so that three of the cables occupy equivalent space to one RG-62/U. Characteristic impedance is 98 ohms. Velocity of propagation, 80 percent, is related to their construction with cellular polyethylene dielectric. A thin wall of nylon under the braid permits soldering both center conductor and braid. Temperature rating is −65 to +120 F.

SPLICING TAPE
for high-voltage use

BISHOP MFG. CORP., 10 Canfield Rd., Cedar Grove, N. J., has developed a new h-v splicing tape that incorporates all of the features desirable for the new ozone resistant power cables operating at higher conductor temperature ratings of 85 C up to and including the 15,000 v

range. Bishop No. 30 is recommended for use on all cables insulated with ozone-resistant compounds and operating at 2,000 v or more. It has superior resistance to the erosive action of both corona and ozone, as well as superior aging properties.



D-C POWER SUPPLY
one of 22 models

OPAD ELECTRIC CO., 69 Murray St., New York 7, N. Y. This low cost 0 to 28 v d-c 10-ampere power supply operates from 115 v 60 cycles a-c, and is one of the 22 standard models described in bulletin No. 178. The bulletin covers unfiltered units rated from 5 to 150 amperes and from 6 to 230 v d-c, all having continuously adjustable outputs and for both 115 v and 230 v a-c operation.

AIRLINE CONNECTORS
for manometer boards

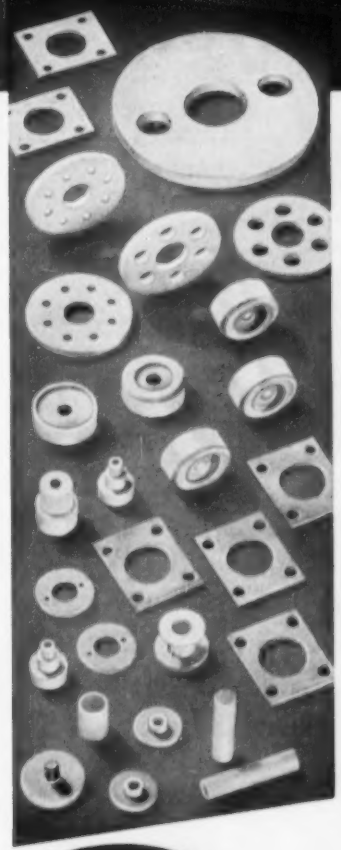
CANNON ELECTRIC CO., 3209 Humboldt St., Los Angeles 31, Calif. Airline tubes in place of current carrying circuits, but using standard AN type shells and coupling nuts, make up the company's line of manometer connectors. Based on the quick disconnect principle of the electrical connector, these manometer fittings are used largely in

TEFLON*

PARTS OR MATERIALS FOR UHF APPLICATION?

FOR MINIATURE AND SUB-MINIATURE COMPONENTS?

YOU CAN GET JUST WHAT YOU WANT from JOHN CRANE



FOR: insulators of all types, sleeves or inserts, capacitor seals, feed through insulators, bushings, slot liners, coaxial spacers, layer insulation or any other parts or forms subject to high charge, extended frequency range, mechanical and thermal shock, extreme temperatures and climatic conditions.

You can order in any quantity and be sure of true Teflon performance, because "John Crane" gives you these *plus* factors: complete uniformity throughout, high density control, freedom from flaws and rigid adherence to your specifications.

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Now is a good time to put "John Crane" to test. Contact Crane Packing Company today.

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Dielectric Strength: 480 v/mil.
Dielectric Constant (60 to 10^8 cycles): 2.0
Power Factor (60 to 10^8 cycles): < 0.0005
Volume Resistivity: 10^{15} ohm-cm
Surface Resistivity: 3.6×10^6 megohms
Surface Arc-Resistance: does not track
Temperature Range: −450° to +500°F.
Chemical Resistance: completely inert
Moisture Absorption: zero

Crane Packing Co.,
1802 Cuyler Ave.,
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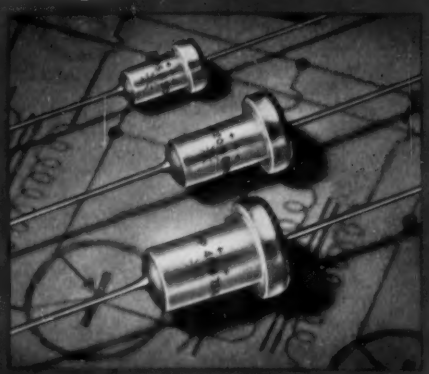
Fansteel
TANTALUM CAPACITORS

Four basic advantages

1. Greatest Capacity in Small Space
2. Practically Unlimited Life
3. Maximum d-c leakage 0.000008 amp.
4. Stable Characteristics over Wide Temperature Range



Incorporating a porous tantalum anode assembly, tantalum capacitors derive their unusual stability from the characteristics inherent in tantalum itself—the most stable of all anodic film forming metals. During twenty years of ever increasing use, these important advantages have become accepted: No important changes of characteristics occur, even in long periods of operation. No shelf aging. Large capacity in extremely small size. Maximum stability and temperature range.

Fansteel offers Tantalum Capacitors in 58 sizes and ratings. All sizes are available from stock. Write for current technical bulletins.

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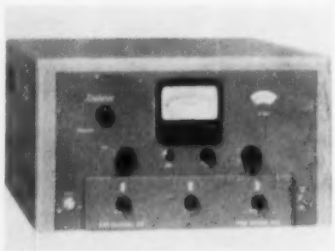
FANSTEEL METALLURGICAL CORPORATION
North Chicago, Illinois, U.S.A.

C955A

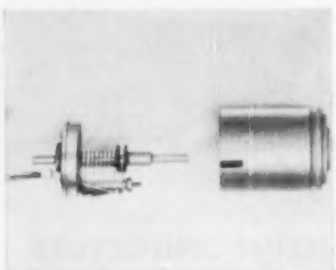
TANTALUM CAPACITORS . . . DEPENDABLE SINCE 1930

wind tunnels for testing of aircraft models, flight tests and other laboratory uses. Up to 200 pressure lines may be routed to a 100-tube manometer board from various parts of the airplane. Ask for bulletin SR-AL-1.



SIGNAL GENERATOR
for aligning tv receivers

KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N. J. The Xtalator, a highly accurate vhf signal generator, is designed to eliminate errors in testing and aligning tv receivers. Elimination of f-m is achieved through the use of a decade switched, crystal stable oscillator. Other features include direct reading and continuous frequency coverage. Range is 50 mc to 250 mc; frequency, direct reading and continuous; output, attenuated 0.5 μv to 0.5 v; frequency accuracy, $\pm$0.005 percent; modulation percentage, 0 to 30 percent; output impedance, 50 or 75 ohms; and price, $1,795.



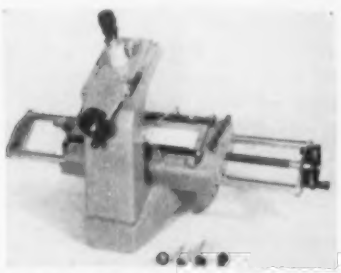
SELECTOR SWITCH
is ultra low torque type

THE ELECTRO TEC CORP., South Hackensack, N. J., has developed a switch with several different brush and circuit combinations. Illustrated is a selector unit with 10 input circuits and one output (break before make). It consists of a rotating element and stationary

brushes. The rotating element is actually a slip ring assembly with a series of commutator segments interconnected to the individual rings. Overall size is less than 1 in. in diameter by 2¾ in. long. The unit is designed for ambient temperatures in excess of 350 F.

BUILDING BLOCK
for digital systems

MAGNETICS RESEARCH CO., 142 King St., Chappaqua, N. Y., has available a basic building block for doing complicated switching operations at speeds up to 200 kc. The Logiblock contains 4 cores, 3 diodes and a buffer amplifier tube. A maximum of 8 input signals can be accepted by the Logiblock and combined to give output signals in accordance with the built-in logic. The Logiblock is split into 2 output sections, each capable of providing inputs to 4 other Logiblocks.



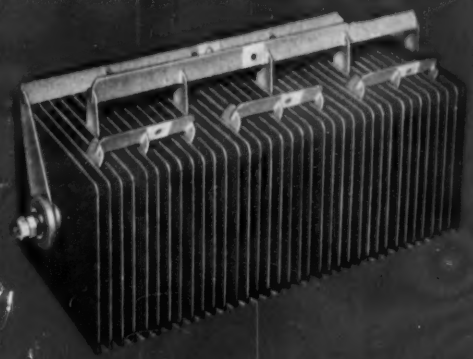
OPTICAL MEASURING INSTRUMENT
is high precision unit

EPIC INC., 154 Nassau St., New York 38, N. Y. The Askania MAM 300/60 is a high precision optical two-dimensional measuring instrument designed and built for efficient and accurate measuring of lengths of recording on photo-

Fansteel

SELENIUM RECTIFIERS

a 31 year record of DEPENDABILITY!



Whatever your rectifier requirements, you can depend on Fansteel's experience and facilities to meet them . . . exactly! From standard Fansteel selenium cells, more than 400,000 different rectifier stack combinations are available. Since 1924, Fansteel's continuing research and development program has paced American industry's growing demand for selenium rectifiers engineered to fill specific needs.

Fansteel High Temperature Rectifiers

Designed for continuous operation at ambient temperatures up to 100°C. with no derating whatsoever. About one-third the size and one-quarter the weight of a standard rectifier rated at 45°C. *Another "First by Fansteel"!*

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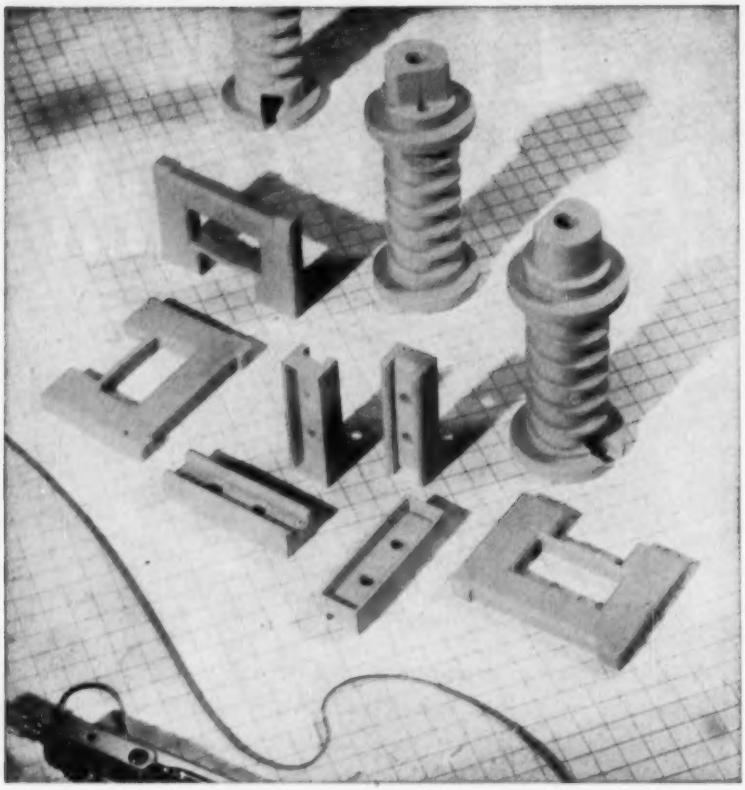
CLEVELAND — 2147 Prospect Avenue SUperior 1-5908
CHICAGO — 3304 North Harlem Avenue TUxedo 9-3200
MILWAUKEE — 2609 West National Avenue ORchard 2-4091
LOS ANGELES — 1015 Hope Street, South Pasadena PYramid 1-2125
DALLAS — 6310 Denton Drive Dixon 4038
HOUSTON — 1301 Caudle Drive HOlbrook 5-3644

FANSTEEL METALLURGICAL CORPORATION
North Chicago, Illinois, U.S.A.

DEPENDABLE RECTIFIERS SINCE 1924

Stupakoff

PRECISION CERAMICS



PRECISION speeds assembly... aids MINIATURIZATION

The high degree of precision maintained by Stupakoff in the manufacture of ceramic parts sharply reduces assembly costs, particularly for miniaturized assemblies. Tolerances of ±0.001 in. are not unusual, even in large production quantities.

Stupakoff Precision Ceramics can be made of alumina, steatite, zircon, magnesia, Stupalith® Titanates, and other materials. Parts are formed by modern methods and may be complex, plain, ground, machined, metallized or assembled.

Complete research and engineering facilities are available to assist you in the design and development of your parts.

Illustration shows a telephone discharge block with precision-made Stupakoff ceramic base. By holding close tolerances on critical dimensions, assembly is speeded and accurate fit assured.

WRITE DEPT. E for CATALOG SECTION 301 describing Stupakoff Precision Ceramics.

Stupakoff

CERAMIC & MANUFACTURING COMPANY • LATROBE, PA.

Division of The CARBORUNDUM Company

graphic plates and for any precision graduation on glass or metal surfaces. Measuring range is approximately 12 in. in x-direction and approximately 2½ in. in y-direction; graduated optionally in millimeters or inches. Accuracy of reading is 0.01 mm. The measuring slide has 6 ball bearings. The microscopic eyepiece has 4 interchangeable objectives of 12, 24, 54 and 74x magnification.

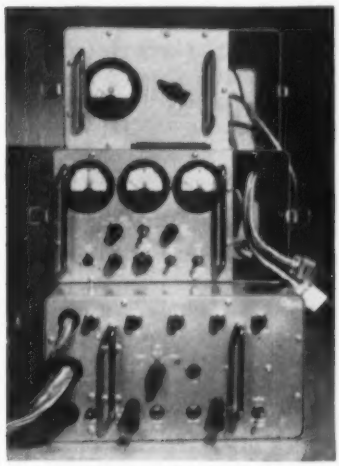
DIGITAL OHMMETER is completely automatic

ELECTRO INSTRUMENTS INC., Box S, Old San Diego Station, San Diego 10, Calif. Model D040 completely automatic digital ohmmeter displays 4 digits accurate to 0.05 percent ±1 digit from 0.1 ohm to 1 megohm in 4 ranges. Range is indicated by a lighted automatically located decimal point and by the symbol Ω or KΩ in the extreme right window. Average reading time is approximately 1 sec. The unit is essentially a self-balancing bridge with the unknown resistance one arm of the bridge. Balance is achieved by automatically adjusting a digital rheostat with stepping switches.

COMPUTER TYPE TUBE features high perveance

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y. Type 6350 is a miniature T-6½ twin triode, designed and developed for use in high-speed digital computers. Featuring long life, high perveance and good power handling, it has a plate dissipation rating of 3.5 w per section. Each section features a

high zero bias plate current, sharp cutoff and a separate cathode connection. The cathode of the new tube is designed to operate at low temperature and special alloys used in its composition control sublimation and cathode interface formation to a slow rate. The test specifications are designed around computer applications that include fixed grid current testing and long life test with factory precautions to minimize interface formation.

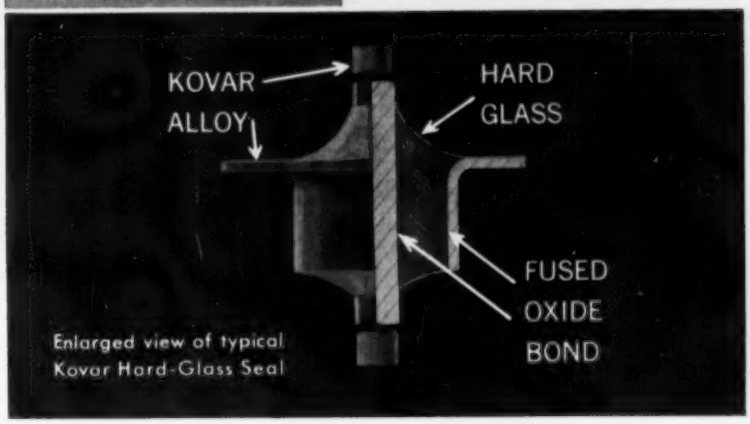


TEST SET
in compact transit case

CAL-TRONICS CORP., 11307 Hindry Ave., Los Angeles 45, Calif. Model 604 test set, contained in a compact transit case, is designed especially for check out of any section of the AN/ARC-34 with minimum of effort and positive results. The test equipment is comprised of a voltage point test set (CTC 10617) similar to the MI-25137, a junction box (CTC 10618) and a tuning control test set (CTC 10619) similar to MI-25138 and an instruction book

Stupakoff

Kovar **HARD GLASS** Seals



Here are 5 practical reasons why

KOVAR AND HARD GLASS

make the Best hermetic seals

BEST *for thermal endurance*
—because the thermal expansion of Kovar matches exactly that of hard glass over the entire working range.

BEST *for insulating value*
—because of the high dielectric strength of hard borosilicate glass. No silicone treatment is required.

BEST *for hermetic tightness*
—because the fused oxide bond is a chemical bond, forming a true hermetic seal, free from strains at all working temperatures.

BEST *for miniaturization*
—because insulating efficiency and high mechanical strength of hard glass permit the use of seals of minimum size and weight.

BEST *for your product*
—because Stupakoff's broad experience, engineering skill and modern manufacturing methods provide hermetic seals that are right for your product. You get all the advantages that can be secured *only with Kovar and Hard Glass.*

WRITE DEPARTMENT E
for Catalog 453A, which shows all the standard and many of the special types of Stupakoff Hermetic Seals.

Stupakoff

CERAMIC & MANUFACTURING COMPANY • LATROBE, PA.

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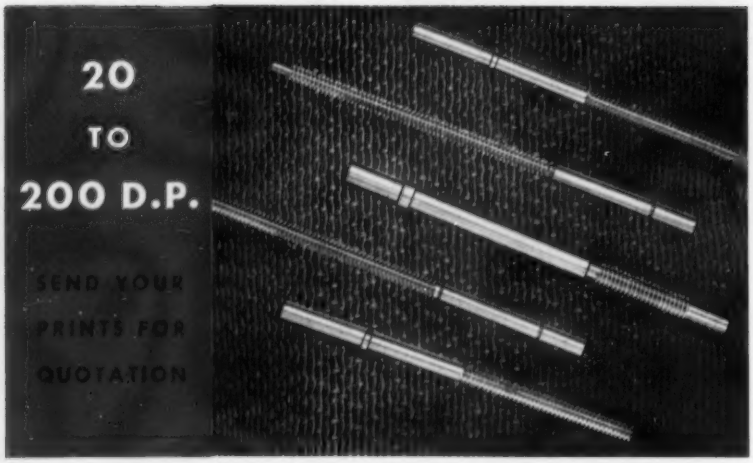

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THE *Finest* IN GEARS

Beaver Gear Works Inc.

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Now... MALCO AUTOMATIC PIN AND CONTACT INSERTING MACHINE FOR PRINTED CIRCUIT APPLICATIONS

...the Most Important Cost-Saving Advancement Yet Offered

Malco's Automatic Pin and Contact Inserting Machine can materially reduce your assembly costs — and at the same time step up production to practically any desired level.

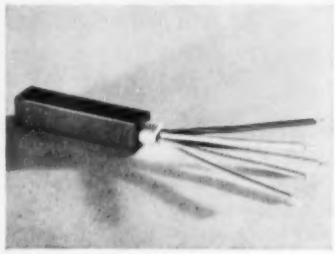
Operation is completely automatic. Up to 40 or more self-retaining terminals are inserted into the printed circuit board in any symmetrical or non-symmetrical pattern within a 3-second cycle. A special platen engages the self-retaining snap-in feature of the terminals, and the board is ready for immediate further assembly and dip soldering.

Malco Automatic Inserting Machines can be engineered to your particular application or production requirements.

Request Bulletin 551. Better yet, give us the facts about your operation. We'll show you how your costs can be lowered and your production increased.

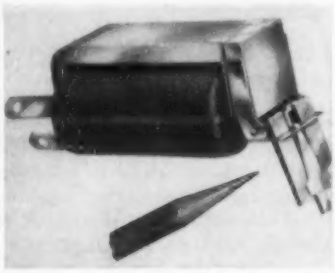
Malco TOOL and MANUFACTURING CO.
4023 W. LAKE ST., • CHICAGO 24, ILLINOIS

along with special purpose patch cables and tools for ease of trouble shooting any of the individual subchassis detached from the main assembly.



MISSILE RELAY
is compact and sensitive

PRICE ELECTRIC CORP., Frederick, Md. Smaller than a cigarette, a new subminiature sensitive relay especially designed for guided missile and other applications requiring an extremely small, compact and sensitive relay has been announced. The new model, Husky 503, is provided with one set of spdt contacts rated at 0.5 ampere, 120 v d-c noninductive. When adjusted to a sensitivity of 0.050 w, the 503 will resist 30-g vibration up to 2,000 cycles. It will withstand operating shock of 50-g for 0.011-sec duration, mechanical shock of 2,000 ft lb and 1,000-g rotary acceleration. The relay contains a new internal mechanism and is less than 2 in. in length and only ⅛ inch square.



JAMES CUNNINGHAM, SON & CO., INC., Rochester 8, N. Y., has announced the model 22A electromagnetic solenoid actuator. Featured is the linkage system available in either a push or pull

arrangement, which magnifies the original air gap movement in an 8 to 1 ratio. The actuator is extremely compact, displacing 1.4 cu in. and weighing 50 grams. It operates on 1.8-w input, within 7 milliseconds at normal voltage. The new linkage design permits even motion with minimum friction-induced loss of energy. The actuator remains cool in continuous operation.

TINY TRANSFORMER
for many industrial uses

TELEX, INC., Telex Park, St. Paul 1, Minn. Redesign of a miniature interstage transistor transformer has produced a model 1/3 smaller than the recent prototype. Measuring $\frac{3}{8} \times \frac{3}{8} \times \frac{3}{8}$ in., the transformer has numerous industrial uses in audio amplifiers, hearing aids, control circuits and other transistorized circuitry. Impedance of the interstage primary is 20,000 ohms, and the secondary is 1,000 ohms. Frequency response is ± 3 db from 150 to 15,000 cps, with 0.25 ma (d-c) in the primary. This transformer will handle up to 0.5 mw.

RELAY
ruugged and supersenstive

OLYMPIC RADIO & TELEVISION INC., Olympic Bldg., Long Island City 1, N. Y., has announced a new rugged supersensitive relay with wide applications in a-c and d-c control circuits. The unit will operate on as little as 20 μw of control power, from d-c to 50 mc a-c. The relay can be packaged for plug-in or wire-in types of assemblies. It is capable of withstanding shocks of 10 g minimum and vibration of 10 g from 10 to 500 cycles without opening or

PANELOC announces a new rotary latch

Saves Cost • Saves Time
Saves Space • Saves Weight

This new Paneloc Rotary Latch is a simple and economical, strong and durable fastener for access panels, electrical control panels, inspection doors, machinery doors, and other hinged or removable covers. It permits a larger access opening, operates quickly with a quarter-turn. Entire assembly on access panel itself, eliminating many installation steps; no special tools required. Only four simple parts; made of steel, cadmium plated. Three standard sizes now available, more to be added. Special sizes and finishes available on order. Cost very low, performance unsurpassed. Write for a catalog and price list for your file.

PANELOC...America's most versatile line of aircraft fasteners . . . Rotary Latches, Styles 1, 2, and 3 Panel Fasteners, High Performance Fasteners, Snap Fasteners.

PANELOC—A product of Scovill

Scovill Manufacturing Company, Aircraft Fastener Div.
46 Mill Street, Waterbury 20, Connecticut
Please send me fastener catalogs checked:
( ) Rotary Latch ( ) Style 3 (MIL-F-5591A)
( ) Styles 1 & 2 (MIL-F-5591A) ( ) High Performance (NAS-547)
( ) Snap Fasteners (AN 227)
Send to:
Name _____ Title _____
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PRECISION

The Only **COMPLETE COIL FORM SERVICE** *Available...*

- SQUARE TUBES
- ROUND TUBES
- RESINITE COIL FORMS
- BOBBINS
- MANDRIL SERVICE
- FABRICATING SERVICE

SQUARE AND RECTANGULAR TUBES

Produced in any length, shape or size from 1/16" to 8", wall thickness from .010 to .125. Fabricated from dielectric kraft, fish paper, quinterra or combinations, including mylar. Bowed sidewall or Di-Formed construction.

ROUND TUBES

Produced in any decimal size up to 8" I. D. Fabricated from kraft, fish paper, cellulose acetate, mylar, polystyrene, quinterra, fibre glass and other dielectric materials.

RESINITE COIL FORMS

These coil forms have the highest resistivity of any resinated product. Furnished plain, embossed, internally threaded or triangular shape . . . also flyback transformer forms.

BOBBINS

Supplied round, square or rectangular. Cores fabricated from any of the above materials. Metal, asbestos, plastic or fibre flanges. Constructed to fit smaller spaces and permit multiple winding.

MANDRIL SERVICE

Accurately ground steel and aluminum coil mandrils at cost economy comparable to commonly used undependable wood or undersized steel mandrils.

FABRICATING SERVICE

We have modern high speed equipment to provide you with any special shape or form . . . rolled, spun, flared, punched or formed to your particular requirement.

Ask about Precision's complete coil form service. Request informative bulletin.

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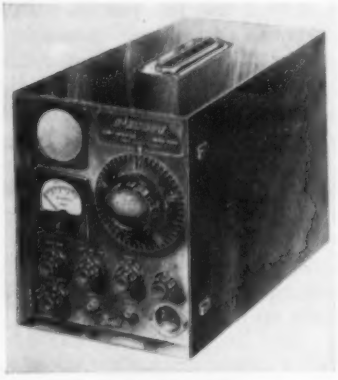
closing contacts. It is completely hermatically sealed to eliminate the effects of humidity and contamination on the relay operations. Power gain available is approximately 75 db for a-c or 80 db for d-c control signals. These relays will function from d-c to at least 50 mc for a-c control inputs. They are available with this power gain in spst to spdt or more complicated arrangements. The unit requires 65 μa and 0.15 v for switching a spdt contact rated at 10 amperes, 115 v a-c. The relay requires an auxiliary power input of 1 w.



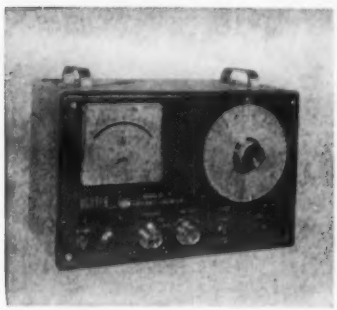
SONIC ANALYZER
for nondestructive testing

KINETIC INSTRUMENT CO., Highland Park, Ill. Model E30A E-scope is a sonic analyzer for nondestructive testing of solid and visco-elastic materials. Features are accuracy, portability and operating convenience in providing measurement of effects of natural or induced deterioration, flaws or inclusions, or product uniformity. It is a self-contained instrument designed for laboratory use, field testing or production quality control. The E-scope

permits sonic testing of glass, wood, metals, plastics, tile, brick, carbon, graphite, ceramics, adhesives, rubber and abrasive wheels.

FLUTTER BRIDGE
is portable and rugged

TELECTRO INDUSTRIES CORP., 35-18 37th St., Long Island City 1, N. Y. The new flutter bridge is specially designed to measure flutter and wow in turntables, tape recorders, wire recorders and motion picture equipment. Measurements in either the 0 to 0.5 percent or 0 to 2 percent ranges are indicated clearly on a large 4-in. square meter. The flutter bridge requires no external power source, is lightweight, portable and rugged. It is presently available for testing equipment with either 4, 8, 16 or 500-ohm impedances.



L-F GENERATOR
features low distortion

DONNER SCIENTIFIC CO., 2829 7th St., Berkeley, Calif. Model 15 1-f generator is a precision source of sinusoidal and square wave voltages having a frequency coverage which is continuous from 0.01 cps to 1,000 cps. The instrument generates a true sine wave without discontinuity of slope, so that differentiation of the waveform yields a signal

AUTOMATIC PRODUCTION AND QUALITY CONTROL TESTING

with the CTI Supertester

The CTI Supertester is an automatic, precision instrument for production testing, fault analysis, and preventive maintenance. It checks electronic and electrical products more completely and in a fraction of the time required by present methods.

Providing complete flexibility and rapid interchangeability between products, the Supertester can be programmed for any combination or sequence of the following measurements:

Impedance	A-C Voltage	Leakage
Resistance	D-C Voltage	Continuity

★ REDUCE TEST COSTS

Requiring only an untrained operator, the Supertester frees valuable technical personnel for specialized work. One Supertester is the equivalent of a series of custom built, single product testers, or a benchful of precision bridges and meters.

★ SPEED PRODUCTION

Complex circuits, gain and frequency measurements, involved relay operations — all are checked at the rate of 180 tests per minute. Hours of manual test procedure have been reduced to minutes. Time is not wasted checking good units.

★ INCREASE PRODUCT QUALITY

Accurately checking every production unit against design values and tolerances, the Supertester does not overlook tests or pass questionable circuits. Original specifications are tirelessly and rigidly adhered to. Instead of checking only the essential circuit parameters, the Supertester tests equipment completely, quickly, and at far less cost.

Proved in Use!

The Supertester is being used daily by a number of the nation's leading manufacturers. Their testing applications include printed circuits, telemetering units, guided missile circuitry and pre-flight tests, and aircraft electronic equipment.

Whatever the problem, rigid test specifications, high production rates, or reducing test costs, automatic testing is the solution, and the CTI Supertester has proved itself to be the efficient, money saving means to this solution.

COLOR TELEVISION INCORPORATED CTI SAN CARLOS 1, CALIF.

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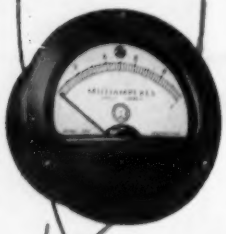
advancement in instrument design

NO GASKETS
NO CEMENTS



The "ORIGINAL" MIL-M-10304 RUGGEDIZED PANEL INSTRUMENT
Hermetically sealed glass-to-metal

MIL 2½" and 3½" sizes. ua, ma, amp, mv, volt, kv, AC rectifier types for voltage, decibel and VU measurement, manufactured to MIL-M-10304. Standard ranges from stock. Twelve page booklet on request.

marion electrical instrument co.
Grenier Field, Manchester, N. H., U. S. A.
Manufacturers of Ruggedized and "Regular" Panel Instruments and Related Products.
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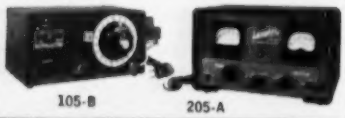
marion meters

Earn Extra Income in MOBILE-RADIO MAINTENANCE!

It's now a big business (650,000 installations) . . . fast-growing (70% increase just last year) . . . specialized . . . and high-paying!

Learn how to turn this opportunity into cash—write today for free booklet "HOW TO MAKE MONEY IN MOBILE-RADIO MAINTENANCE!" It's published as a service to radio engineers by Lampkin Laboratories, Inc., manufacturers of the well-known 105-B Micrometer Frequency Meter and 205-A FM Modulation Meter.

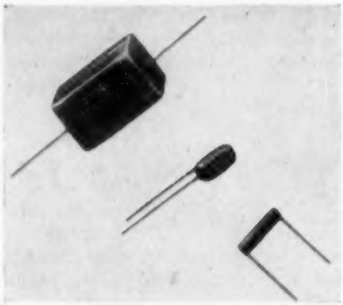


105-B 205-A

LAMPKIN LABORATORIES, INC.
Instruments Div., Bradenton, Fla.

At no obligation to me please send "HOW TO MAKE MONEY IN MOBILE-RADIO MAINTENANCE."
Name
Address
City State

with low noise. Feature are exceptional frequency stability and low distortion. Total frequency drift is less than 0.5 percent. Frequency range is covered in five decade bands and tuning is by means of a 6-in. high-resolution, individually-calibrated dial accurate to within 1 percent. The instrument uses a 4 in. zero-center meter with mirror-scale to facilitate accurate setting of the sinusoidal output level at any frequency. The meter indicates rms value in the frequency range from 1 cps to 1,000 cps. Below 1 cps the meter indicates the instantaneous value of output voltage, showing both amplitude and phase of the oscillation.



LEADS
conserve space

HOPKINS ENGINEERING CO., 2082 Lincoln Ave., Altadena, Calif. Axial leads, radial leads and single-end parallel leads are the newest features of the company's subminiature metallized paper capacitors. The new lead locations not only lend themselves strongly to the electronic field of automation, but also are important for maximum space conservation. These leads are available in all capacitor sizes as well as on special units designed for specific requirements. Hopkins metallized paper capacitors are funginert plastic encased and rectangular in shape.

R-F WATTMETER
of the calorimetric type

M. C. JONES ELECTRONICS CO., INC., Bristol, Conn., has developed a calorimetric type r-f wattmeter that measures r-f power with the pre-

Scouting for Incapsulated Coils?

DANO MAKES THEM!

Dano, makers of a wide variety of coils, is fully equipped to meet the increasing demand for these special coils. Keeping pace with modern design, Dano offers incapsulated coils with tough, molded covers that spell extra electrical insulation with freedom from moisture.

Every Dano Coil is custom-made to your specific requirements. Call or write today, and Dano's quote will be on the way!

- Incapsulated Coils
- Form Wound
- Bakelite Bobbin
- Cotton Interweave
- Paper Section
- Acetate Bobbin
- Coils for High Temperature Applications
- Also, Transformers Made To Order

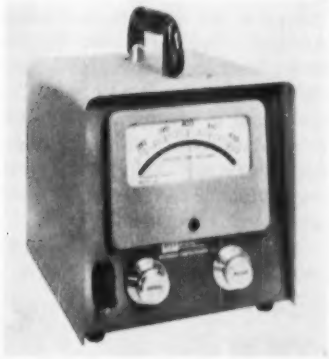
The DANO Electric Co.
MAIN ST., WINSTED, CONN.

BE SAFE WITH
Q-max
A-27
LOW-LOSS LACQUER & CEMENT

- Q-Max is widely accepted as the standard for R-F circuit components because it is chemically engineered for this sole purpose.
- Q-Max provides a clear, practically loss-free covering, penetrates deeply, seals out moisture, imparts rigidity and promotes electrical stability.
- Q-Max is easy to apply, dries quickly and adheres to practically all materials. It is useful over a wide temperature range and serves as a mild flux on tinned surfaces.
- Q-Max is an ideal impregnant for "high" Q coils. Coil "Q" remains nearly constant from wet application to dry finish. In 1, 5 and 55 gallon containers.

Communication Products Company, Inc.
MARLBORO, NEW JERSEY (MONMOUTH COUNTY)
Telephone: FReehold 8-1880
C-P

cision of a primary standard. The 641N wattmeter can be used to check the accuracy of other types of r-f wattmeters, and to determine the actual output of an r-f power source, the approximate magnitude of which is known. Over the entire frequency range of 0 to 3,000 mc the instrument has an accuracy of better than ±2 percent of full scale, using the calibration curve supplied. It measures power in the range from 0 to 300 w. For more accurate measurements it may be calibrated by the user at d-c or 60 cycles.



FREQUENCY METERS
accurate to ± ¼ cycle

SHASTA DIVISION, Beckman Instruments, Inc., P.O. Box 296, Richmond, Calif., has available a unit designed for fast, accurate monitoring of frequency. It was designed originally for making production inspection measurements on the frequency regulation of motor and engine-driven generating units, but has found many other applications, particularly where a permanent record of frequency is required. Input voltage harmonics of 5 percent, or changes in input voltage of ±10

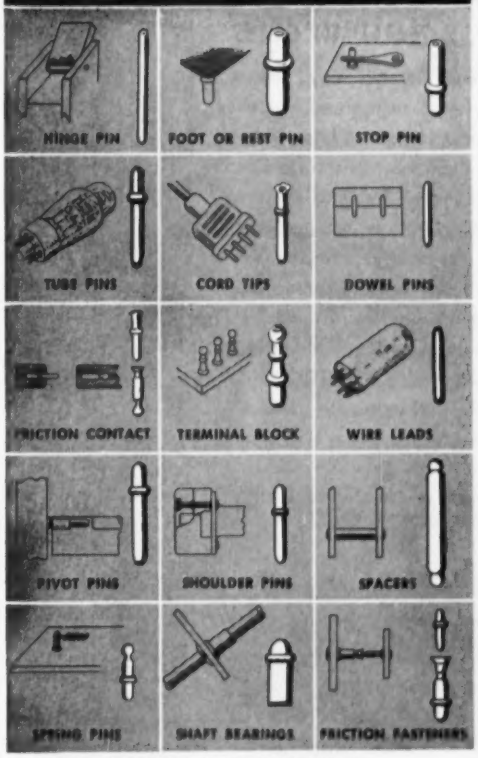
SMALL PARTS can play a BIG PART in...

Lower Production Costs!

Multi-Swage METHOD

Leading manufacturers in the electronics, machinery, appliance and toy fields have been saving substantially by using precision Multi-Swage parts instead of those previously made by turning, drilling, stamping or forming.

HERE ARE ONLY A FEW TYPICAL TINY PARTS MADE BY BEAD CHAIN'S *Economical, Dependable* MULTI-SWAGE METHOD



LET BEAD CHAIN MAKE YOUR

Tiny Parts to your Specifications at far less cost!

The advanced manufacturing method developed and used exclusively by Bead Chain swages practically any type of small tubular part from flat stock into precision forms with positive, tight seams . . . and does it *Automatically*. If you can use high-volume production . . . we can deliver it at a much faster rate . . . and at far less cost! Scrap is eliminated! Deliveries to you are dependably prompt!

We can supply you with parts that are beaded, grooved, shouldered and made with almost any metal. Diameters up to ¼", lengths to 1½"

This catalog can save you a lot of production time and money! Write for it today!

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Send us a blueprint or sample and quantity requirements. We will quickly show you the big economies we can deliver.

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BRIDGEPORT 5, CONNECTICUT

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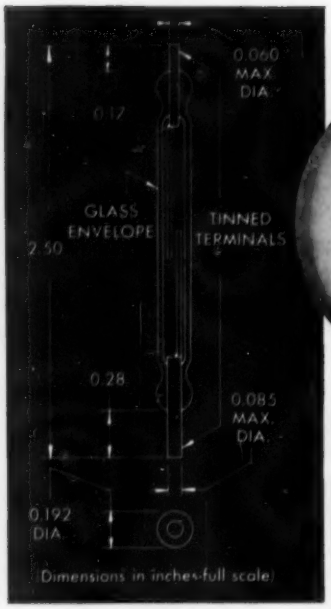
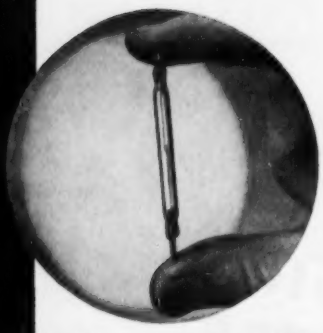
THE BEAD CHAIN MANUFACTURING CO., BRIDGEPORT 5, CONN.





the mighty little glaswitch*

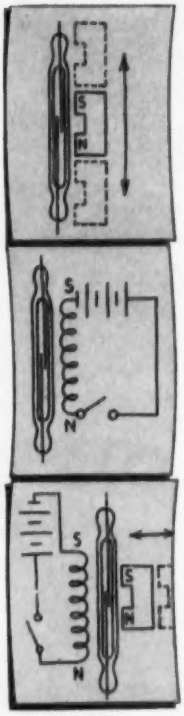
LIGHTNING RESPONSE . . . SEALED IN GLASS

The magnetically actuated reeds in this tiny Revere GLASWITCH make contact in just 1 millisecond . . . at rates up to 400 cycles per second. Hermetically sealed in an inert, dry atmosphere, with lightning fast snap action, both shelf and contact life are extremely long. Smaller than a cigarette, the GLASWITCH can be located anywhere . . . in any position . . . even in explosive atmospheres . . . individually or in multiples for multi-contact use.

Whenever you need faster, more positive response . . . where extreme sensitivity is a must . . . where light weight is important . . . investigate the Revere GLASWITCH. Write today for complete specifications and suggested uses.

CHARACTERISTICS:

Type—Single pole single throw—normally open—snap action
Enclosure—Hermetically sealed glass tube containing inert dry atmosphere
Operating Time—1 millisecond
Operating Rate—Up to 400 cycles per second
Contact Surfaces—Electroplated Rhodium
Contact Resistance (measured terminal-to-terminal)
Closed Circuit—0.050 ohms maximum
Open Circuit—500,000 megohms minimum
Contact Ratings
D.C. Loads at 28 volts
0.5 amps resistive
0.5 amps inductive (L/R—0.026)
A.C. Loads at 115 volts, 60 cycles
10 watt lamp load
Ambient Temperature Range— —85°F to +500°F



METHODS OF ACTUATION:

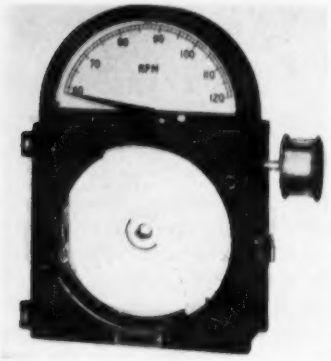
A moving permanent magnet or controlled external electromagnetic field are all you need . . . and the sky's the limit on imagination!

* Trademark

Revere CORPORATION OF AMERICA

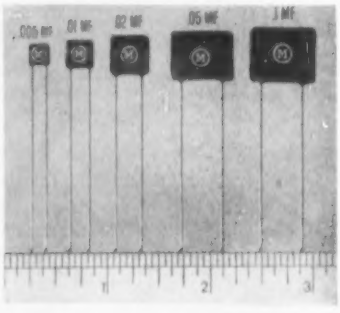
WALLINGFORD, CONNECTICUT A subsidiary of Neptune Meter Company

percent will not cause errors in frequency indication greater than ±½ cycle for the model 401 or ¼ cycle for the model 601.



TACHOMETER
indicates and records

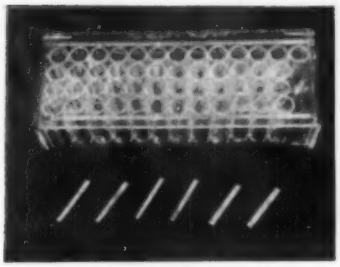
AMTHOR TESTING INSTRUMENT CO., INC., 45-53 Van Sinderen Ave., Brooklyn 7, N. Y. Type No. 317 indicating and recording tachometer automatically records the operation of the machine on which it is installed. It shows the speed and rate of production at any time and every change in speed. It shows the starting and stopping times, all slowdowns and nonproductive periods, the time and duration of each, and the actual producing and idle time. These data are valuable in increasing operating efficiency, cutting production costs and enforcing strict observance of schedules.



SMALL CAPACITORS
for transistor circuits

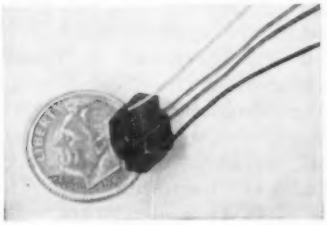
MUCON CORP., 9 St. Francis St., Newark 5, N. J., announces a line of high-capacitance subminiature ceramic capacitors whose small size

makes them ideal complements for transistors. Rated at 25 v d-c, these units are available in 5 stock capacitance values ranging from 0.005 μf to 0.1 μf, measuring 13/64 in. sq. max. to 17/32 in. max. by 21/32 in. max., with thickness from 0.090 in. max. to 0.110 in. max. Made of Super-K ceramic material, these capacitors have radial No. 26 leads, and are normally used from 5 C to 40 C. The units are finding wide application for bypass, coupling and tone control circuits in personal transistor radios, auto receivers and other subminiature equipment.



TAPE RESISTOR KIT
useful for laboratory work

HANSEN ELECTRONICS Co., 7117 Santa Monica Blvd., Los Angeles 46, Calif. Designed for laboratory use in experimental or development work involving the use of tape resistors, the type RNP-1C kit includes 10 each of the 49 standard MIL-R-11A values from 100 ohms to 1 megohm, inclusive, in ±10 percent tolerance. The kit is etched to show the various values, making it easy to identify each type RNP value quickly and accurately. Price of the complete kit is $49.50.



TRANSFORMER
reduced in size and weight

GRAMER-HALLDORSON TRANSFORMER CORP., 2734 N. Pulaski Rd., Chicago

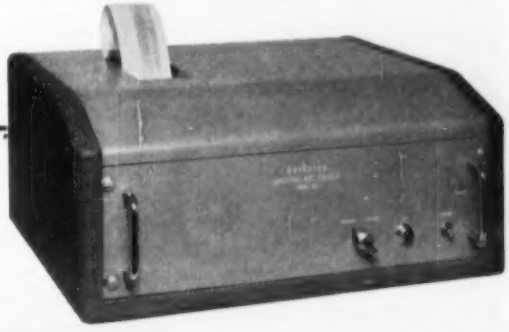
Save Time, Reduce Errors... Determine and Record Data Automatically with These Two Versatile Berkeley Instruments

Model 5510 Universal Counter and Timer offers direct-reading digital display of count, frequency or microsecond time interval. Time bases from 1 mc. to 1 cps; gate times from .00001 to 10 sec. Accuracy ± 1 count, ± crystal stability (1 part in 10^6). Price $1,100.00 f.o.b. factory.

1. UNIVERSAL COUNTER AND TIMER, Model 5510, combines the functions of four instruments in one single, compact unit. It will:
   a. Count at speeds to 1 million per second.
   b. Count events occurring during a selectable, precise time interval.
   c. Measure time intervals in 1 microsecond increments, from 3 microseconds to 1 million seconds.
   d. Determine frequencies or frequency ratios from 0 cps to 1 megacycle.
   e. Operate directly the BERKELEY printer (below), BERKELEY digital-to-analog converter, or BERKELEY data processor to drive IBM card punches, typewriters or teletype systems.

2. BERKELEY DIGITAL RECORDER, Model 1452, combines scanner and high speed printer in a single unit; prints up to 10 digits on standard adding machine tape. Can be modified to print "Time" or "Code" information simultaneously with count data on same tape.

Model 1452 prints 6 digits (8 or 10 on special order) on standard adding machine tape. Is only 19" wide x 10½" high x 14" deep, weighs 60 lbs. Price, $750.00 f.o.b. factory.



Write for complete specifications and data; G-9

M-43

Berkeley division BECKMAN INSTRUMENTS INC. 2200 WRIGHT AVE., RICHMOND, CALIF.

INDUSTRIAL INSTRUMENTATION AND CONTROL SYSTEMS • COMPUTERS • COUNTERS • TEST INSTRUMENTS • NUCLEAR SCALERS

CO-AX
4 mmf/ft
ULTRA LOW capacitance & attenuation
WE ARE SPECIALLY ORGANIZED TO HANDLE DIRECT ORDERS OR ENQUIRIES FROM OVERSEAS
SPOT DELIVERIES FOR U.S.
BILLED IN DOLLARS— SETTLEMENT BY YOUR CHECK
CABLE OR AIRMAIL TODAY
TYPE | μμF/ft | IMPED.Ω | O.D.
C 1 | 7.3 | 150 | .36"
C 11 | 6.3 | 173 | .36"
C 2 | 6.3 | 171 | .44"
C 22 | 5.5 | 184 | .44"
C 3 | 5.4 | 197 | .64"
C 33 | 4.8 | 220 | .64"
C 4 | 4.6 | 229 | 1.03"
C 44 | 4.1 | 252 | 1.03"
NEW 'MX and SM' SUBMINIATURE CONNECTORS
Constant 50Ω 63Ω 70Ω impedances
TRANSRADIO LTD. 138A Cromwell Rd. London SW7 ENGLAND
CABLES: TRANSRAD, LONDON

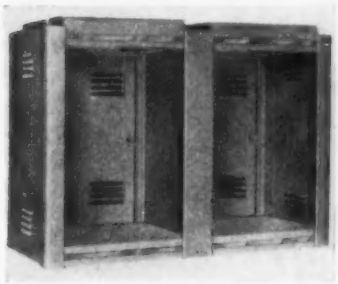
SPACE SAVERS FOR MODERN CIRCUITRY –
MONEY SAVERS FOR PRODUCTION ECONOMICS –
IN-RES-CO
TYPE IR
WIRE WOUND
RESISTORS
The practical, low cost solution for circuit designers striving for the subminiature. Type IR units offer precision resistance values capable of retaining stability through long periods of continuous or intermittent service. Type IR resistors are available at prices based on mass production methods of manufacture. Wound to a tolerance of ±1%, they are permanently accurate. Conservative ratings allow ample safety margin in all classes of service. Special Bakelite forms eliminate shrinking, swelling and temperature effects. IN-RES-CO moisture and fungus proof coating offers absolute protection against climatic extremes. Specify IR Type resistors for all applications where precision performance and limited space are important determining factors.
INSTRUMENT RESISTORS CO.
COMMERCE AVENUE
IN-RES-CO
UNION NEW JERSEY
WRITE FOR NEW RESISTOR HANDBOOK – Contains complete data and recommended applications for resistors for every purpose.
APPLICATION-DESIGNED RESISTORS FOR ELECTRONICS AND INSTRUMENTATION

39, Ill., has introduced a new Miniformer miniature transformer. Designed primarily to meet the smaller space requirements of hearing aid components, it also has applications in computers, pocket radios, f-m transceivers, telephone recorders and airborne equipment. The unit measures only $\frac{1}{2}$ in. × $\frac{5}{16}$ in. × $\frac{3}{8}$ in. and weighs but 0.004 lb. The 100W72 interstage transformer illustrated has a match impedance of: primary, 20,000 ohms; secondary, 1,000 ohms. Primary d-c resistance is 1,030 ohms; secondary, 167 ohms. Power rating for primary inputs from 1 v to 7 v is 2.5 mw. Other impedance matches are also available. Leads are color-coded, high-temperature plastic insulated.

INDUCTION HEATER
for light heat treating uses

LINDBERG ENGINEERING CO., 2450 W. Hubbard St., Chicago 12, Ill. A new 3-kw h-f induction heating unit (Model LI-3) is designed for brazing, hardening, and other light heat treating applications. It is also used for quickly melting small quantities of ferrous and nonferrous metals for spectroscopic analysis, and like operations, in research laboratories. The all steel cabinet is heavily constructed to protect internal components from damage and minimize r-f radiation. A double compartment shields h-f oscillator from d-c power supply and controls. Heavy duty industrial type vacuum tubes are used throughout with oscillator tube air cooled to eliminate large volume water requirements. Filament voltages to all tubes are automatically

controlled by voltage regulating transformers. Bulletin 1470 gives additional details.



MULTIPLE RELAY RACK
available in four sizes

PREMIER METAL PRODUCTS CO., 3160 Webster Ave., New York 67, N. Y., has announced a multiple relay rack unit. Enclosed relay racks for standard 19-in. rack panels can now be jointed together to make multiple units by a solid center partition bolted to the top and bottom. Each multiple section consists of a top, bottom, rear door and center partition. Multiple units are available in four sizes: 36¾ in., 42 in., 61¼ in. and 77 in.

T-W TUBE AMPLIFIER
for C-band use

HUGGINS LABORATORIES, INC., 711 Hamilton Ave., Menlo Park, Calif. This traveling-wave tube features broadband operation from 4 to 8 kmc without the necessity of making any electrical or mechanical adjustments. It finds its greatest use where this broadband characteristic can be utilized such as r-f preamplifiers and untuned r-f receivers in systems applications. It is also used extensively in broadband microwave measurement techniques in the laboratory. Grid control is provided for variable gain and power output applications. Approximate operating characteristics over this band are 30-db gain and 10-mw output. The unit requires a 300-

HEILAND OSCILLOGRAPH CHARTS "NIGHTGLOW" ON LONELY MOUNTAIN PEAK

Dr. Franklin E. Roach, consulting physicist to the National Bureau of Standards, loads a record take-up drum into the Heiland oscillograph.

On wind-swept "Fritz Peak" in the Colorado Rockies, the broad capacity of the Heiland 712 oscillograph goes to work on every cloudless and moonless night, charting the airglow in the sky.

Charting these night-light phenomena formerly required 30 minutes, but a complete record of the skies is now taken every 3 minutes.

A 4-telescope Photometer—installed at the top of the 9,000 foot mountain—sends information on the amount and quality of light in the skies to the Heiland 712 Oscillograph located in the trailer laboratory below. Heiland galvanometers convert these data into clear, easily-readable oscillograms for later study.

The National Bureau of Standards "Airglow" Project is engaged in a study of the earth's upper atmosphere. It is expected that this research will reveal high-speed fluctuations in the airglow, which originates in that part of the upper atmosphere known as the ionosphere.

Heiland Series 700-C Recording Oscillographs provide record widths as great as 12 inches, accommodate up to 60 channels and have record speeds through 144 inches per second. Galvanometers with unequalled sensitivity ratings are available in frequencies up to 5000 cps.

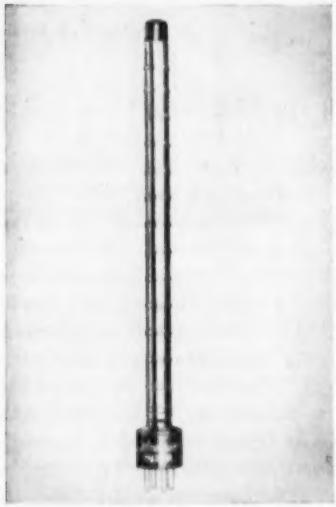
• **Write for Bulletin 700 CFPK for details.**
Visit the Honeywell Booth, ISA Show

Heiland® H HONEYWELL
A DIVISION OF MINNEAPOLIS-HONEYWELL
130 E. 5th Ave., Denver 3, Colo.

gauss field and a 700-v regulated power supply.

MAGNETIC CLUTCH

STERLING PRECISION INSTRUMENT CORP., 34-17 Lawrence St., Flushing 54, N. Y. Model T502 is a high-speed, precision electromechanical component for all types of control, computer and servo systems. It can be mounted on a single hanger like any standard servo motor. Mounting is identical to Mk8 Mod 0 servo motor.



GEIGER TUBE
with 7-in. cathode

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y. The type 912NB Geiger tube, because of its 7-in. cathode, obtains much higher sensitivity and greater pulse height. It is used for the detection of beta and gamma radiation in monitoring equipment and

Designed for

Application

The No. 90901
One Inch
Instrumentation Oscilloscope

Miniaturized, packaged panel mounting cathode ray oscilloscope designed for use in instrumentation in place of the conventional "pointer type" moving coil meters uses the 1" 1CP1 tube. Panel bezel matches in size and type the standard 2" square meters. Magnitude, phase displacement, wave shape, etc. are constantly visible on scope screen.

JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY
MALDEN
MASSACHUSETTS

NOW!
more for your connector dollar...
with these rugged nylon tip and banana plugs!
Illustrated above—Johnson's new nylon insulated banana plug. Below—a cut-away view of the new nylon insulated tip plug ... two of the toughest, most durable connectors available today!

Look at these features:

- Shock-proof nylon insulating handles—won't chip or crack with the hardest usage.
- provides high voltage insulation.
- Highly resistant to extremes of heat, cold and moisture.
- Special design for simplified solderless connection of up to 16 gauge stranded wire.
- Economical—simple, functional engineering design gives you top quality at low cost.

SPECIFICATIONS

BANANA PLUG—nickel-plated brass construction with nickel-silver springs. Spring plug is .175" diameter, fits all standard banana jacks. **TIP PLUG**—recessed metal head is fully insulated, preventing exposure of metal surfaces when tip plug is engaged in any standard tip jack. Metal parts are brass, nickel-plated. Pin is .081" diameter—fits all standard tip jacks. Available in 11 bright colors to match Johnson nylon tip jacks.

Also New

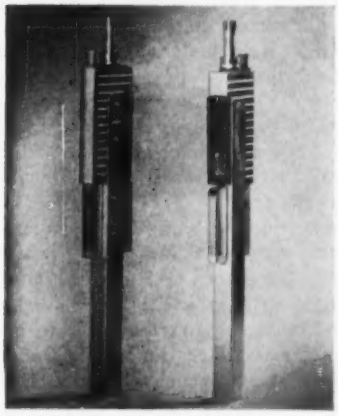
NYLON TIP JACK AND INSULATING SLEEVE

Complete assembly includes a standard nylon tip jack with a threaded nylon insulating sleeve. Ideal for patch cords, this assembly is also excellent for panel mounting, where an insulated rear connection is desired.

Investigate today! Write for prices, further information.

E. F. JOHNSON COMPANY
2331 SECOND AVE. S.W. • WASECA, MINN.

survey instruments. The 912NB has a stainless steel cathode, 39/64 in. i.d. and a wall thickness of 30 mg per cm^2. Minimum plateau length is 200 v; operating voltage is 900 v. The tube is fully described in the radiation tube catalog, which is available on request.



GALVANOMETERS
for direct recording

CONSOLIDATED ENGINEERING CORP., 300 N. Sierra Madre Villa, Pasadena 15, Calif., has released the first five of a new high-performance series of galvanometers. The instruments permit accurate recording of dynamic signals up to 200 cps without amplifiers. Several of the units are electrically interchangeable with CEC's present 7-300 units, but feature extended frequency response. Other members of the high-performance family are distinguished by extremely high sensitivity and are expected to be used where maximum resolution or recording of low-level signals is required. Types are available for direct connection to commonly used 120, 180, and 350-ohm strain gages and resistance-type pickups. Further information and complete specifications are given in bulletin 1559.

PHOTOCONDUCTIVE CELL
cadmium-sulfide type

RADIO CORP. OF AMERICA, Harrison, N. J., has introduced a small

brand new!

BRUBAKER
electronics, inc.

marker pulser *

A PRECISION MARKER-GENERATOR AND PULSE-GENERATOR FOR MANY LABORATORY AND PRODUCTION LINE USES!

SPECIAL FEATURES

- *Output pulse width, 0.1 to 10 microseconds*
- *Output pulse rise and fall time, 0.03 microseconds*
- *Output pulse repetition rate 100 to 5000 pps*
- *Synchronizing pulse width 3 microseconds*
- *Forced air cooling*
- *Compact construction*
- *Illuminated panel and markings*
- *Inset rear deck for ease of connections, with detachable line cord and standard video and sync cables*

Now you can make precision time measurements with one combination marker-generator and pulse-generator. Use the time-tested Brubaker Marker-Pulser (with a broad-band oscilloscope) for measurements of delay lines, filters, video-pulse amplifiers, pulse transformers, and pulse-forming networks. Use it to calibrate other test equipment. All outputs are locked together to provide completely jitter-free synchronization of output pulses, scope-marker pulses, and scope synchronizing pulses. And for flexibility of use, the output pulses and scope-synchronizing pulses are variable with respect to each other as well as to the scope markers. Measurements of time delays in increments of 0.01 microseconds are made rapidly by means of a calibrated dial which reduces necessity for operator interpolation of scope traces.

* Trade Mark

The Marker-Pulser is time tested. It has been used continuously to test Brubaker delay lines. And Brubaker is the LARGEST PRODUCER OF PRECISION DELAY LINES. We will be glad to quote on YOUR requirements.

BRUBAKER ELECTRONICS, INC.
9151 Exposition Drive • Los Angeles 34, California

BIRD Model 43 Thruline DIRECTIONAL WATTMETER

Reads Directly . . . **WATTS FORWARD**

WATTS REFLECTED *. . . In 50 Ohm Coaxial Lines*

Measures POWER into the antenna in the actual operating circuit. Continuous monitoring if desired.

Measures reflected power, direct reading. In antenna matching work, results show directly in lower reflected power.

Ideal for mobile equipment.

Tests 50 ohm r-f lines, antenna connectors, filters—quickly.

ACCURATE because of high directivity and small frequency error.

DIRECT READING – no calibration charts, no full scale meter adjustments needed. Meter scale reads directly for all ranges and is expanded for better down-scale reading.

CONVENIENT – does not require reversal of r-f connections. No auxiliary power required.

Negligible power loss and insertion VSWR.

Full scale power range and frequency range are determined by the selection of plug-in elements from the following list.

Frequency Range—25-1000 megacycles in five ranges vis. 25-60 (A), 50-125 (B), 100-250 (C), 200-500 (D), 400-1000 (E).

Power Range—10, 25, 50, 100, 250, and 500 watts full scale. Available in most frequency ranges.

Accuracy— 5% of full scale.

Write for literature.

Model 43 with front element in operating position. Dimensions: 7" x 4" x 3" Weight, 4 pounds.

SO239 jacks for PL259 plugs available.

BIRD ELECTRONIC CORP.

1800 EAST 38TH ST., CLEVELAND 14, OHIO

TERMALINE Coaxial Line Instruments

VAN GROOS COMPANY
Sherman Oaks, Cal.

RON MERRITT COMPANY
Seattle

DIRECT TEMPERATURE MEASUREMENTS

UP TO 3700° F.

IRIDIUM vs. RHODIUM IRIDIUM THERMOCOUPLE WIRE

The only thermocouple material which may be used at these very high temperatures in an oxidizing atmosphere.

Ductile wire made possible by high purity and our advanced melting and drawing techniques.

Output Over 10 milivolts at 3700°F.

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Since 1901

Specialists in the Unusual

SIGMUND COHN MOUNT

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Metallurgists and Producers of Small Wire

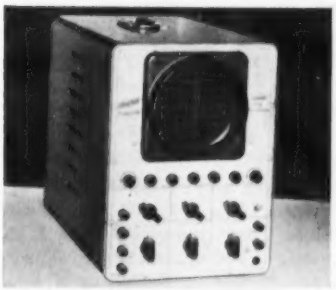
121 SOUTH COLUMBUS AVE., MOUNT VERNON, N. Y.

cadmium-sulfide photoconductive cell of the head-on type designed especially for light applications where a single tiny photosensitive device is required. The new cell (6694) features high luminous sensitivity, extremely low background noise, and a signal output which is directly proportional to the intensity of the light falling upon the cell. It is useful for light-controlled relay applications, in computer systems, and in light meters for measuring the brightness of small luminous spots. The cell's spectral response covers the visible range from 3,500 to 5,500 angstroms with maximum sensitivity in the green region of the spectrum. The 6694 has a maximum length of only 0.19 in., a maximum width of 0.34 in., and a maximum depth of 0.185 in. Minimum photosensitive area is 0.02 × 0.018 in. Ratings, characteristics and operating considerations are included in an available technical bulletin.

DECADE COUNTERS
with plug-in construction

RANSOM RESEARCH, P. O. Box 382, San Pedro, Calif., has developed miniaturized electronic decade counters weighing 6 to 8 oz with miniature tubes in place they employ the new direct-reading EIT decade-scaler tube and replace older versions weighing 11 oz. Four types are available—a 20-kc scaler, a 40-kc scaler, a 100-kc scaler and an output stage scaler operating at 10 cps which can be used to feed a

mechanical counter. The 20-kc, 40-kc and 100-kc counters are available with or without an input-shaper circuit. Plug-in construction makes them particularly useful as building blocks to form any desired combination. Dimensions of all models are $1\frac{5}{8}$ in. × $2\frac{1}{4}$ in. × $3\frac{1}{16}$ in. exclusive of tubes. One to three miniature-type tubes supplement the EIT decade-scaler tube.



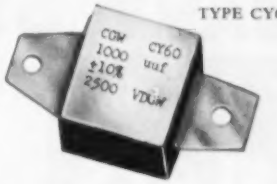
FIVE-IN TV SCOPE
has wide-band response

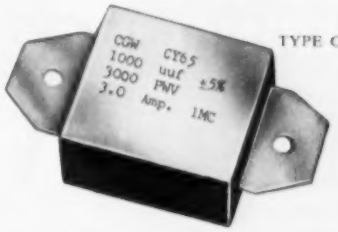
HICKOK ELECTRICAL INSTRUMENT Co., 10527 Dupont Ave., Cleveland 8, Ohio. Model 675 high-sensitivity wide-band scope features a calibrated and illuminated scale with a green filter to reduce reflections caused by incidental illumination. The scope has a frequency response of 1 cps to 4.5 mc (within 3 db) and is flat through the color burst frequency of 3.58 mc. Sensitivity is 20 mv rms per in. Variable writing speeds are available from 25,000 μsec per in. (based on 4 in.). Additional technical features are available from the company.

Literature

Relays and Switches. Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill. Bulletin RH No. 8 describes how the company's electric relays and stepping switches are being utilized in the design and construction of an advanced circuit analyzer used in the testing of electrical systems. Use of the relays and switches discussed

Electrically, Corning Glass Capacitors replace mica types CM45 thru CM70. The CY60 is physically interchangeable with mica types CM45–CM61.

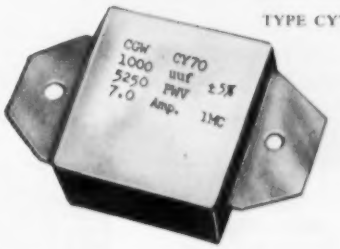




Corning

Medium-Power

Transmitting Capacitors



offer the dielectric uniformity and stability of all-glass design

You'll notice a definite departure in physical form between these capacitors and those previously available for RF use.

The purpose of this is to take fullest advantage of glass in medium-power transmitting work in power amplifiers, low-power transmitters, low-power oscillators, TV transmitters and other electronic devices in grid, plate, coupling, tank and bypass functions.

Their small size and light weight make them ideal for aircraft and other mobile transmitters.

Characteristics and advantages

Glass Dielectric is formed as a homogeneous, continuous ribbon free of holes, cracks, foreign inclusions and other imperfections. This creates a highly-stable, low-loss dielectric.

Temperature Coefficient . . . +140 ppm/° C. over a range of +25° C. to +85° C. Variations in TC between capacitors at any given temperature up to 125° C. are negligible; and the TC remains the same after repeated cycling.

Capacitance Drift . . . In no case exceeds ±.1% +.1 uuf.

Capacitance, Voltage and Power Ratings . . . Available in capacitance values to 100,000 uuf; voltage ratings to 6,000 peak-working volts; power ratings to 7.8 KVA at one megacycle.

You can get Corning Medium-Power Transmitting Capacitors *now*. For full, detailed information, write, wire or phone.

You can also get Fixed Glass Capacitors with Pigtail Leads AND *Glass Subminiature Tab-Lead Capacitors with many unusual advantages. Ask for facts.*

CORNING GLASS WORKS
New Products Division • **36-9 Crystal St., Corning, N. Y.**
Corning means research in Glass

Please send me the descriptive catalog sheet on Corning Medium-Power Transmitting Capacitors.

Name..... Title.....
Company.....
Address.....
City..... Zone..... State.....

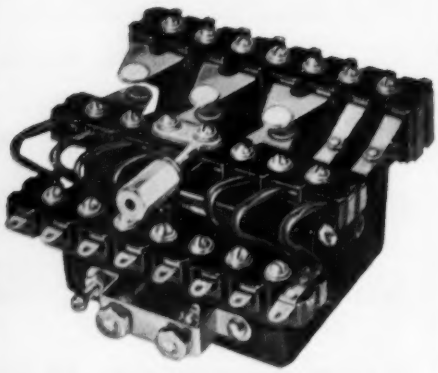
HEAVY DUTY

Multiple Arm

RELAYS

by **SIGNAL**

- Versatile — Rugged
- Cast Aluminum Base
- High Shock and Vibration Resistant
- Available AC — DC
- Contact Capacities Available 10; 35; 50 amp.
- Contact Combinations on Same Base
- Designed to Meet Many MIL Spec's



A superior relay that has endured the test of time . . . Specified for many years by America's largest manufacturer of electrical controls and communications equipment.

For complete data, write for Bulletin No. 30-6

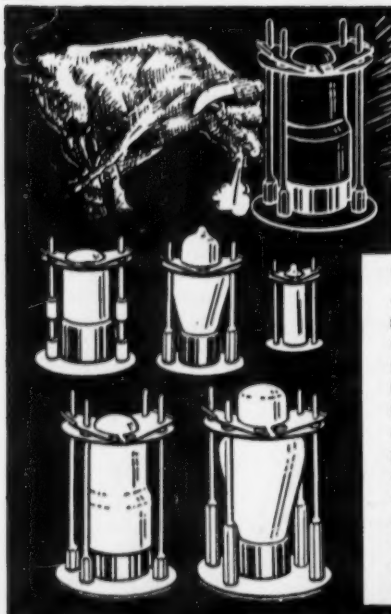
Engineering representatives in principal cities

Wheelock **RELAYS**

SIGNAL

ENGINEERING & MFG. CO.

LONG BRANCH NEW JERSEY



SHOCK PROOF

VACUUM TUBE RETAINERS

These retainers are used to secure Vacuum Tubes and to resist side motion of Vacuum Tubes used in radio equipment which is subject to shock and vibrations. These retainers meet the requirement of all JAN specifications. The insulated portion is made of a melamine base Fibre Glass Phenol which provides 300 volts insulation to ground and withstands a temperature of 350 F. The insulated plate can readily be fastened or released by hand.

Available for envelope types T7, T8, MT8, T9, T12, ST12, T12ZDI, ST14, S14, ST16, T5½, T6½, MT-IC, ST19, T14, ST12SCT-9.

Manufacturers of Electronic Components

JAMES IPPOLITO & CO., INC.

401 CONCORD AVENUE, BRONX 54, N. Y.

has produced an analyzer with improved speed, accuracy ease of operation and dependability.

Portable Potentiometers. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. Complete information about single, double and triple-range portable potentiometers widely used for numerous emf measurements in plant and laboratory, is available in data sheet E-51(2). The concise sheet lists instrument features and tabulates the characteristics of each potentiometer for ready comparison.

Continuous Thickness Measurements. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Data sheet No. 10.9-1a describes thickness or weight control of pages, rubber, foil, coatings and other moving sheet materials. Thickness or weight per unit are continuously measured and controlled by Tracerlab beta gages equipped with Brown ElectroniK instruments. Applications, principles, features and instrumentation are given as well as sections on accuracy and personnel protection.

Computer Brochure. J. B. Rea Co., Inc., 1723 Cloverfield Blvd., Santa Monica, Calif., is offering a 12-page brochure on the READIX, a general purpose, fixed and floating point computer designed for business data processing, scientific computation, data reduction or automatic control. In addition to operational data on the READIX, the brochure covers such features as the low price, built-on test equipment and simplified maintenance.

Rectifier Recording Instruments. The Esterline-Angus Co., Inc., P. O. Box 596, Indianapolis 6, Ind. Bulletin 455 illustrates and describes the model AW rectifier recording instruments. Uses shown are typical of applications to be found in any plant. Specifications for the 50 ma split-core current transformers are included.

Components Catalog. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass. Catalog 500 includes complete specifications, actual size illustrations and schematic

drawings of all the company's standard electronic and electrical components. Solder terminals and swagers, terminal boards, hardware, insulated terminals, coil forms and wound coils, and capacitors are each given a complete section and full details for ordering the many types of each unit are included. The catalog is three-hole punched for easy reference and filing.

Magnetic Components. Raytheon Mfg. Co., 100 River St., Waltham 54, Mass. A 16-page bulletin 4-100, describes in detail the wide variety of specialized magnetic components produced by the company for use in all types of electrical and electronic equipment. Well illustrated with photos, circuit diagrams, and output curves, the booklet covers equipment designed for both power and signal applications such as transformers, magnetic amplifiers, filters and delay lines. Also included is a section on unusual and interesting design features incorporated in many of the Raytheon units.

A-F Carrier. North Electric Co., Galion, Ohio. A new low-cost signaling system designed specifically to fill expanding subaudio or d-c signaling needs is described in a 4-page bulletin. The system described utilizes either frequency shift or frequency modulation for transmitting signaling information. It permits teletype, telegraph, telemetering, and other subaudio or d-c signaling to be multiplexed over open wire, telephone carrier, radio, microwave or any system capable of carrying voice frequencies. The bulletin contains photographs and specifications of the system.

Laboratory Standard Instruments. Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J. The company's laboratory standard instruments and standard cells are fully illustrated and described in catalog A46A. Also included is expanded information on frequency coverage, frequency compensation and waveform effect pertaining to the model 326 voltmeters, ammeters and wattmeters.

Digital Converter. Norden-Ketay Corp., 555 Broadway, New York 12,

transistor and
digital computer techniques

APPLIED TO THE DESIGN, DEVELOPMENT AND APPLICATION OF

AUTOMATIC RADAR DATA PROCESSING, TRANSMISSION AND CORRELATION IN LARGE GROUND NETWORKS

Engineers & Physicists

Digital computers similar to successful Hughes airborne fire control computers are being applied by the Ground Systems Department to the information processing and computing functions of large ground radar weapons control systems.

The application of digital and transistor techniques to the problems of large ground radar networks has created new positions at all levels in the Ground Systems Department. Engineers and physicists with experience in the fields listed, or with exceptional ability, are invited to consider joining us.

FIELDS INCLUDE

TRANSISTOR CIRCUITS • DIGITAL COMPUTING NETS • MAGNETIC DRUM AND CORE MEMORY • LOGICAL DESIGN • PROGRAMMING • VERY HIGH POWER MODULATORS AND TRANSMITTERS • INPUT AND OUTPUT DEVICES • SPECIAL DISPLAYS • MICROWAVE CIRCUITS

Scientific and Engineering Staff

HUGHES
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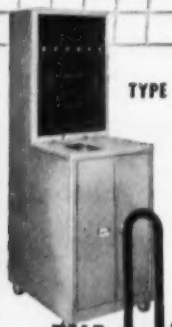
Culver City, Los Angeles County, California

70 mm.
for
one
millivolt
yet drift-free



THE OFFNER DYNOGRAPH

0.001 volt input d-c gives 70 mm. deflection with this high-speed direct writing oscillograph, many times that for competitive units. The Dynograph with *one amplifier* is used for all types of inputs for measuring speed, temperature, position, vibration, and other variables. Patented, chopper amplifier design makes it sensitive, stable, and versatile. Available in both 6 channel console model and single and dual channel portable models. *Get bulletin L742—compare the Dynograph with all competitive models—it combines sensitivity with absolute stability.*

OFFNER ELECTRONICS INC.
5324 N. Kedzie Avenue
Chicago 25, U. S. A.

N. Y. The recent 4-page bulletin No. 360 has applications, specifications, characteristics and an installation drawing of the new ADC-1 digital converter. The converter described has an unambiguous output of 13 binary digits and operates at high speed in clockwise or counter-clockwise operation.

VTVOM. Hycon Mfg. Co., 2961 E. Colorado St., Pasadena 8, Calif. Model 614 vacuum-tube volt-ohmmeter is illustrated and described in a single-page flyer. Included are the many advantages, specifications and price ($87.50).

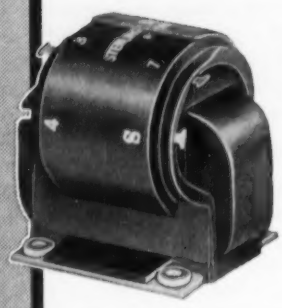
Tube Selection Chart. General Electric Co., Schenectady 5, N. Y. A selection chart listing 40 of the company's 600-ma series-string receiving type tubes—all of controlled heater warmup design—is now available. It classifies the tubes according to elements; lists typical service, heater voltages, maximum plate and screen dissipation ratings; and gives average characteristics. Ask for ETD-1163.

Resistance Precision Meter. Federal Telephone and Radio Co., 100 Kingsland Road, Clifton, N. J., has available a catalog sheet describing the type RGV resistance precision meter. Resistance range of the unit discussed is from 0.01 ohm to 100 megohms in seven ranges. Technical specifications, dimensions, weight, uses and operation data are included in the catalog sheet.

Program Control. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Bulletin 1130, "Program Control of Process Variables," describes the methods and advantages of employing automatic, time-conditions control for many industrial processes and tests. A convenient selection chart aids in choosing the right instruments for any program control application.

Transistor Noise Figure Test Set. Radio Receptor Co., Inc., 251 W. 19th St., New York 11, N. Y., has available a bulletin giving a general description and technical specifications for the model TS-101 transistor noise figure test set. The

MOLDED
OPEN TYPE
TRANSFORMERS
THE
CLIPPER
SERIES



Built to pass MIL-T-27 specifications, including Grade I humidity tests, and to operate continuously at 150°C (Class C).

Result: Savings up to 50% in space and weight without sacrifice in performance.

SAMPLES?
SPECIALS?
SHORT RUNS?

The Clipper is only one of the many types we make. We specialize in custom-built transformers to your specifications. Let our engineering staff help solve all your transformer problems.

Samples delivered in 1 to 3 weeks

Write for Literature

STERLING
TRANSFORMER
CORPORATION
297 North 7th St. Brooklyn 11, N. Y.
STagg 2-4200

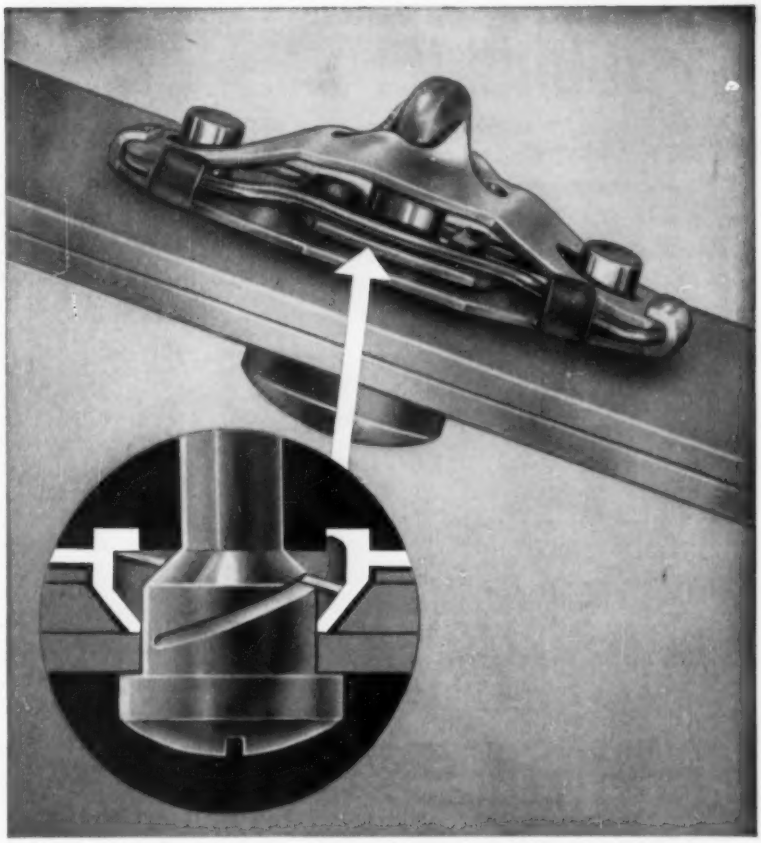
equipment described is intended primarily for production test service by both manufacturers and users of transistors.

Ruggedized Panel Instruments. Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J. Catalog A38B fully illustrates and describes the complete line of ruggedized and sealed panel instruments in 1½ in., 2½ in., 3½ in. and 4½ in. sizes, a-c, d-c, r-f and thermo, in both commercial and military types. Instruments in 2½, 3½ and 4½ in. have an external zero corrector, and all instruments may be readily opened and resealed using only an ordinary screwdriver. The catalog includes information on design and construction features, and on the test procedures employed to insure dependable accuracy in service under extremes of shock, vibration, temperature, humidity and general abuse.

Connectors. Alden Products Co., 117 No. Main St., Brockton, Mass., has released a new handbook section featuring integrally molded h-v cable disconnects and tube caps. The connectors described provide a low cost method of connecting and disconnecting voltages up to 30 kv, including corona free tube caps up to 25 kv. Originally developed to meet rigid color tv requirements, the connectors discussed can satisfy similar requirements in transmitters, x-ray gear, h-v supplies and other similar applications. A choice of insulation and wire types is provided so as to meet unusual operating conditions.

TV Transmitters. Allen B. DuMont Laboratories, Inc., Clifton, N. J. Bulletin TR-884 covers the series 100 (channels 2-6) and series 200 (channels 7-13) 50-w tv transmitters. Included are an illustrated description and technical specification listings for the aural and visual transmitters.

Ultrasonic Cleaning Equipment. Acoustica Associates, Inc., Shore Road, Glenwood Landing, L. I., N. Y. Bulletin DR-400 describes ultrasonic cleaning equipment for production cleaning and degreasing of precision products for elec-



New Lion "Hi-Strength" fastener completely assembled. Cutaway shows the beveled counter sink. Beveling substantially increases the area over which stress is distributed.

NOW! Shear strength *twice* that of any other fastener!

New Lion "Hi-Strength" design fills every need for parts that must be fastened, taken apart, buttoned tight quickly

Here's a new and better answer to your problem of metal-to-metal fastening where high shear stress and vibration are factors.

It's the Lion "Hi-Strength" fastener, combining speedy quarter-turn opening and closing with a shear strength of 4750 lbs!

This "Hi-Strength" fastener is remarkably strong because shear load is distributed evenly over the area of the fastened parts. The secret lies in the *beveled* counter sink in the sheet and the nut. It's the same high shear principle used for years by the automotive industry for wheel lugs.

In addition to high shear strength, its tensile strength is 3000 lbs. Sheet separation is zero up to 4750 lbs. Misalignment is as much as .125 with high shear qualities. Regardless of the number of times it's opened or closed, there is no wear. It cannot be overtorqued (up to 3750 lbs.). It cannot be fastened incorrectly. It is no larger than a standard No. 5!

To test it yourself, write for a free mounted working sample. Just drop us a line on your company letterhead.

L·I·O·N *Quarter-turn* FASTENERS

one of the SOUTHCO® FASTENERS

Southco Division
South Chester Corp
233 Industrial Highway
Lester, Pa.

I found it!

say leading design and development engineers . . .

ACEPOT

the smallest wire-wound precision potentiometer

Available single or up to 6-gang units on one shaft.

½" Size—Linearity .3%—High Resolution—200-Ω-to 50K*

torque: .035 oz./in. @ 20° C.
power rating: 2 watts for 60° C. rise
meets applicable portions of MIL-E-5272A standards

ambient temperature: —55° C. to 125° C.
*Resistance Range: 200 ~ to 50K standard, ± 2%. Higher or lower on special order.

Standard, servo or flush mountings . . . dual or up to 6-gang units.

The case and threaded mounting bushing is one-piece anodized aluminum for maximum heat dissipation. The shaft is centerless ground stainless steel. Standard bearing in aluminum or bronze insert. Available for lower torque requirements with ball or jewel bearings. All units fully sealed, moistureproofed, fungicide treated.

Our unique manufacturing and testing facilities *assure you of controlled quality.* Each ACEPOT is performance tested and a Polaroid picture record is supplied showing linearity and resolution.

Send for specification sheet, application data sheet and prices. Your inquiry will receive prompt attention.

ACE ELECTRONICS ASSOCIATES

125 Rogers Avenue, Somerville 44, Mass.

ACEPOT, ACETRIM trademarks applied for.

ACETRIM

½" size
linearity 3%
10 ~ to 50 K ± 5%

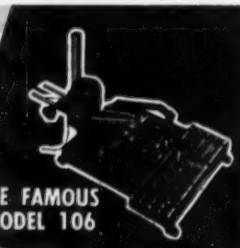
ACETRIM . . . a low-priced, sub-miniature trimmer potentiometer with the same fine characteristics as the ACEPOT. Meets MIL standards. Available standard or shaft lock. Stops if required.

unique in design — rugged in construction

GREEN PANTOGRAPH ENGRAVERS

THE NEW HEAVY-DUTY MODEL D-2

THE FAMOUS MODEL 106



The three-dimensional bench Model 106 cuts costs — engraves, routs, models and profiles, giving you expert results even by unskilled workers.

The Model D-2 heavy-duty two dimensional Pantograph is a precision machine with a multitude of new features. Open on three sides, it permits complete freedom for engraving, milling, profiling large panels (up to 30" in diameter) or bulky pieces. Single, micrometer adjustment controls vertical depth of cut, automatically adjusting copy table with pantograph. Range of reduction ratios from 2-to-1 to infinity! Vertical range over 10 inches!

For complete information, write to

GREEN INSTRUMENT COMPANY

363A Putnam Ave. Cambridge, Mass.

tronic, electrical, radio and tv, photographic and instrument manufacturing industries. A photograph of the ruggedly constructed, portable one-knob control unit, an explanation of its above-audibility sound wave principle of operation, and complete specifications are presented.

Soft Solder Alloys. Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J., has new literature available showing some of their special soft solder alloys in chart form. The bulletin also contains brief descriptions of the alloys and some of their suggested uses.

Silicon Junction Diodes. Hughes Aircraft Co., Culver City, Calif. A new 8-page booklet illustrates and describes a line of silicon junction diodes that are particularly useful in applications for which germanium devices are not suitable by virtue of temperature limitations. The silicon diodes discussed are characterized by excellent forward conductance, together with extremely high back resistance. Specifications and general product information are included.

Overpotential Testers. Beta Electric Corp., 333 E. 103rd St., New York 29, N. Y., has prepared a databook giving full information on d-c overpotential testing. It contains a detailed compilation of data on the principles involved and a bibliography of material on testing techniques. Full description of the portable and mobile series 3000 testers is included.

Electromagnet System. Varian Associates, Palo Alto 2, Calif., has published data sheets and specifications on the V-4004 completely matched 4-in. electromagnet system. The system described is ideal for studies of susceptibility, Zeeman or Hall effects; for testing magnetic materials; for lecture demonstrations; and for many other applications requiring a magnetic field.

Motor Catalog. The Peerless Electric Co., West Market St., Warren, Ohio. An 8-page catalog describing the company's line of ½ to 30-

hp, single-phase, polyphase and d-c motors is now available. Bulletin SDA-155 gives information on how to select the proper motor; things the manufacturer should know about the motors you require; standards and specifications to which Peerless builds; and data on fractional and integral horsepower frame sizes.

Power Supply. John Fluke Mfg. Co., Inc., 1111 W. Nickerson St., Seattle 99, Wash. A recent flyer covers the model 400 BDA 500 to 5,100-v dual polarity d-c power supply. Complete freedom from annoying jitter, bounce and corona, and inherently excellent stability make the unit described ideal for exacting requirements of photomultiplier, proportional counter and ionization chamber work. Specifications are included.

Fastener Catalog. The Palnut Co., 61 Cordier St., Irvington 11, N. J. A 16-page catalog of lock nuts and fasteners for radio, tv and electronic assembly has been published. Included are complete details of advantages, dimensions and applications of lock nuts for assembly of chassis, speakers, controls, switches, record changers, tone arms, transformers and rectifier stacks. Also included are wing lock nuts for antennas and focus coils; shield can fasteners; coil tube fasteners; tension type lock nuts for tuners; plus information on power and manual wrenches and assembly methods.

Electronic Tachometer. Sunshine Scientific Instrument, 1810 Grant Ave., Philadelphia 15, Pa. Catalog No. 19 is a 4-page bulletin covering an electronic tachometer that will measure speed over a range of 0 to 1,000 cps, or 0 to 60,000 rpm, with a sustained high accuracy of 0.2 percent. Chief features, applications, operation information, specifications and ordering directions are given.

Audio Products. Electro-Voice, Inc., Buchanan, Mich. Condensed catalog No. 123 on the company's product lines is now available. The 16-page booklet includes basic information on tv and broadcast,

VHF

. . . Very High Frequencies

RADIO INTERFERENCE and FIELD INTENSITY*
measuring equipment

Stoddart NM-30A • 20mc to 400mc

Commercial Equivalent of AN/URM-47

PRINTED CIRCUITRY . . . Modern printed circuits offer many advantages over conventional wiring, lighter weight, more compact units and freedom from many of the troubles normally encountered in conventionally-wired electronic equipment. Vibration becomes even less of a problem with printed circuits, adding to the many portable features already available with Stoddart equipment.

ADVANCED DESIGN . . . Specialized engineering and modern production techniques have produced one of the most advanced instruments for the accurate measurement, analysis and interpretation of radiated and conducted radio-frequency signals and interference ever manufactured. Designed to laboratory standards, rugged, and with matchless performance, the versatile NM-30A is an outstanding example of modern instrumentation. Its frequency range includes FM and TV bands.

SMALLER SIZE . . . A wider frequency range and higher standard of performance is incorporated into an equipment whose size is one-third that of any similar equipment ever manufactured.

SENSITIVITY . . . Sensitivity ranges from one to ten microvolts-per-meter, depending upon frequency and antenna in use.

APPLICATIONS . . . Field intensity surveys, antenna radiation pattern studies, interference location and measurement for checking radiation from virtually any mechanical or electrical device capable of generating or radiating radio-frequency signals or interference.

Stoddart RI-FI* Meters cover the frequency range 14kc to 1000mc

VLF
NM-10A, 14kc to 250kc
Commercial Equivalent of AN/URM-68. Very low frequencies.

HF NM-20B, 150kc to 25mc
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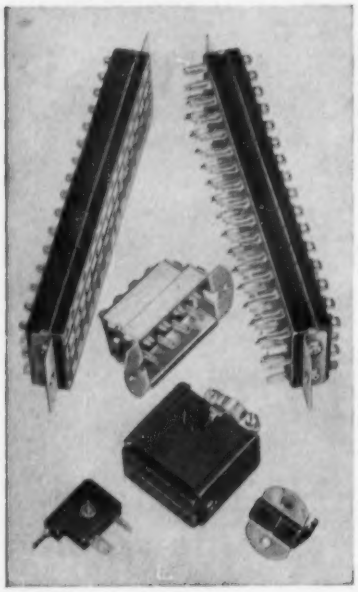

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TRANSFORMERS

public-address, recording, communications and special-purpose microphones and accessories. It also gives information on E-V Circlotron amplifiers, and explains the CDP compound diffraction, p-a loudspeaker systems.

Voltage-Regulated Power Supplies. Kepco Laboratories, 131-38 Sanford Ave., Flushing 55, N. Y. Twenty voltage-regulated power supplies for research and industrial use are illustrated and described in a 2-color 6-page folder. Voltage, current, regulation and ripple for each are listed in tabular fashion. A price sheet is also available.

VTVM's. Hewlett-Packard Co., 3327A Page Mill Road, Palo Alto, Calif., has available a 4-page catalog folder on its vacuum-tube voltmeters. Included are illustrated descriptions and specifications for the models 400AB (10 cps to 600 kc), 400D (10 cps to 4 mc) and 410B (20 cps to 700 mc).

Terminal Bulletin. Hermetic Seal Products Co., 29-37 South Sixth St., Newark 4, N. J., has available a 4-page brochure on Vac-Tite compression, single terminal feedthroughs and standoffs. The parts illustrated are of Vac-Tite (glass-to-metal chemically bonded compression) construction. Complete technical data and drawings are included.

Toggle Switches. Network Mfg. Corp., 213 W. Fifth St., Bayonne, N. J., has available a specification sheet on the series 1600 UL approved toggle switches of a single-hole flush mounting design. It provides illustrations, complete ordering data, mechanical and electrical information.

Electronic Flow Meters. The Hays Corp., Michigan City, Ind. Publication 55-1074-222 is a 12-page bulletin discussing several mercury-less transmitters offered with the company's electronic flow meters. The instruments described are designed for measurement of differential pressures; liquid level; fluid, gas, air or steam flow; temperatures and pressures. They fea-

ture 6-counter continuous integration, 12-in. uniformly graduated charts and choice of several style indicators. A combination of flows or flow and level can be recorded on the same chart.

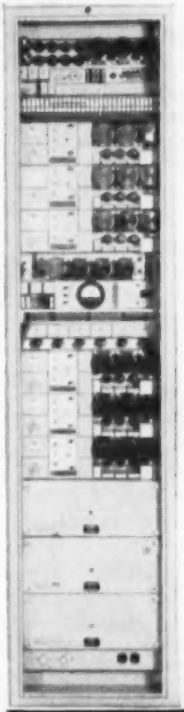
Radio Communications Equipment. Raytheon Mfg. Co., 100 River St., Waltham 54, Mass. Product data sheet PD 3-255 describes the cue-link model ACL-3, a frequency-modulated radio communications system designed to provide a means of maintaining permanent or mobile two-way communications between transmitter and receiver microwave sites. The literature carries data on design features and operation of the equipment as well as a description and specifications of this highly portable communications system.

Engineering and Research Booklet. Stromberg-Carlson Co., 100 Carlson Road, Rochester 3, N. Y., has available a booklet that outlines pictorially and in copy the company's activities and accomplishments in the fields of electronics and communications. The company's six engineering departments and three service laboratories are described and a detailed summary of what has been done and what can be done is included.

Recording Microphotometer. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Data sheet No. 10.16-20 contains data on operation, construction, and accuracy, and general information on the new Wihtol recording microphotometer.

Radiation Instruments. Technical Measurement Corp., 140 State St., New Haven 11, Conn., has published a 20-page catalog illustrating and describing numerous new laboratory instruments. Included are such instruments as liquid phosphor counters, scalers, linear amplifiers, rate meters, ultrastable power supplies, scintillation detectors and crystals.

Toroidal Inductors. Torocoil Co., 1374 Mobile Court, St. Louis 10, Mo., has released a brochure con-



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New and exclusive techniques in the design and manufacture of filters and oscillator networks provide a higher degree of frequency stability than has previously been possible, with resultant reduction in signal distortion. This equipment is in current production, and early deliveries can be made of complete systems or of single panels.

Typical 6-channel packaged terminal of type F2 equipment. This is the type AN/FCC-12 (Channels 1-6) or AN/FCC-13 (Channels 7-12) Telegraph Terminal, as manufactured for the U.S. Army Signal Corps. It is complete with regulated-tube rectifiers for plate and bias supply, and positive and negative telegraph loop-current supplies, jack field, relay test panel, monitor circuits, fuses, spares, etc. The equipment is moisture- and fungus-proofed, and meets military standards where applicable. Up to four cabinets may be used together, to provide a completely self-contained 24-channel terminal.

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ELECTRONIC SWEEP SYSTEM

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taining complete information for the use of the design engineer in selecting the particular high Q toroid most suitable to any desired application. Such necessary information as Q versus frequency, self-resonant frequency, current carrying characteristics and physical dimensions are included together with complete pricing information.

Capacitors and Company Facilities. Micamold Electronics Mfg. Corp., 1087 Flushing Ave., Brooklyn, N. Y. Plant facilities, typical capacitor products and a brief summary of the company's history of serving the industry are contained in a 12-page illustrated brochure. A number of capacitors, used for a variety of applications, are presented by means of photographs and text, as are the company's production facilities, shielded laboratories and test equipment. Biographies of key personnel are also included.

Clip Catalog. Mueller Electric Co., 1582 E. 31st St., Cleveland 14, Ohio, has issued a new, revised catalog on a line of electrical and electronic clips and insulators. The illustrated catalog No. 180 covers all late revisions, including the many new miniaturized and special insulated clips.

Experimental Transistor. Radio Receptor Co., Inc., 251 W. 19th St., New York 11, N. Y. Bulletin G-50A covers the RR125 transistor, which has been especially designed to meet the demand for a transistor that can be used by the professional or amateur experimenter who desires to familiarize himself with various circuits utilizing these devices. The bulletin contains specifications and a diagram for an experimental crystal receiver, with one stage of transistor audio amplification.

Transformers. Chicago Standard Transformer Corp., Addison and Elston Avenues, Chicago 18, Ill. A new 24-page catalog is a completely revised and expanded reference book, listing 543 transformers and related components. It contains illustrations as well as

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detailed electrical and physical specifications for each unit. The catalog has a comprehensive classified index and separate headings for each type of transformer to enable the user to quickly locate the transformers needed.

Power Motor-Gear-Train. John Oster Mfg. Co., 1 Main St., Racine, Wisc. A new catalog sheet illustrating and completely describing the company's power motor-gear-train is now available. Technical data include dimensional drawings, performance features and a table giving motor length, gear train length and related data.

Hydrogen Thyratron Tubes. Kuthe Laboratories, Inc., 730 South 13th St., Newark 3, N. J. An illustrated data sheet covers some of the company's hydrogen thyratron tubes. Included is the No. 6587, a miniaturized, ruggedized hydrogen thyratron (with hydrogen reservoir) capable of replacing the 5C-22, HT-415 and KU-25, and providing a higher rating, more rugged performance and longer life. Specifications are given.

Servomechanism Booklet. Norden-Ketay Corp., 555 Broadway, New York 12, N. Y. Bulletin 362 is a 16-page manual giving specifications and characteristics of over 130 synchros, servo motors, resolvers, and tools and adapters.

Quick-Disconnect Connectors. The Deutsch Co., 7000 Avalon Blvd., Los Angeles, Calif. Bulletin PD-1 discusses electrical quick-disconnect connectors which can be used where equipment requires frequent removal, repair or replacement, installation in cramped or inaccessible quarters, fast action such as on gun firing systems, or for frequently connected or disconnected test equipment. The bulletin also contains information on how the quick-disconnect works, and a description of the insulation material, pin and socket contacts. Specification information includes a brief description of various shells and dimensions on through wall mounting and box mounting receptacles, straight and 90-deg elbow plugs. There is also a listing of AN inserts which are available

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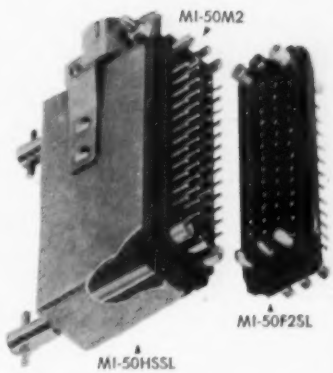

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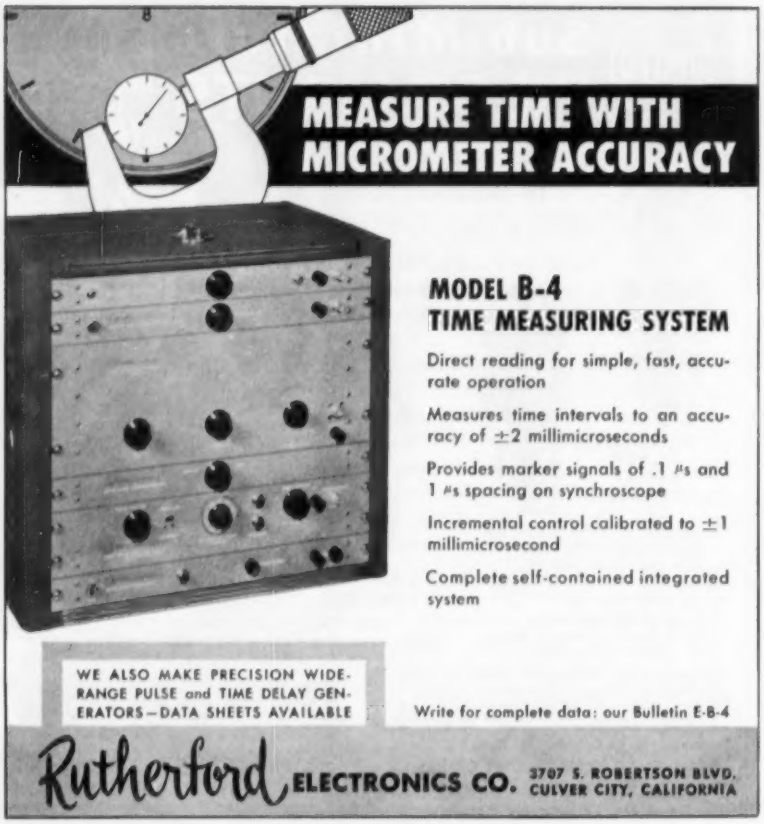
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in the various quick-disconnect shells.

VHF Notch Diplexer. Prodelin, Inc., 307 Bergen Ave., Kearny, N. J. Bulletin 429 is a 2-page catalog sheet illustrating and describing the type DNTV-25 vhf notch diplexer which is necessary when diplexing visual and aural tv transmitters into a Prodelin tri-loop tv broadcasting antenna. Electrical and mechanical specifications and installation information are included.

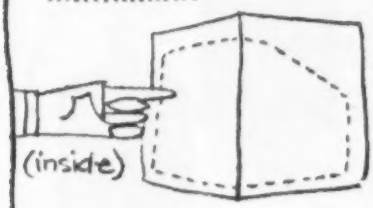
Potentiometer. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. Bulletin K-200-455 is a 2-page, illustrated color bulletin covering features, technical data and outline drawing of new high resolution potentiometers designed for low torque, high function angle applications.

Winder and Wire Insulating Equipment. Geo. Stevens Mfg. Co., Inc., Pulaski Road at Peterson, Chicago 30, Ill., has available a new catalog sheet. One side illustrates and describes model 418-AM automatic variable pitch space winder, including technical data on types of windings, maximum o-d of coil, maximum coil length, winding speed and similar information. The other side of the sheet illustrates model WS-1 wire insulating equipment and gives complete information on function, production capacity and wire sizes handled, description of unit, level-wind device, double insulation, motor equipment and multistrand Litz covered wire.

Rotary Stepping Switch. Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill. Bulletin RH No. 6 describes how one type of rotary stepping switch is being used in a new, improved electronic computing machine. The circular explains the part played by the switch in recording data, solving mathematical problems and delivering answers in printed form.

Chopper Data. James Vibrapowr Co., 4050 N. Rockwell St., Chicago 18, Ill., has released technical data on its 1200 series of choppers. The series described is a dpdt design incorporating a new operating mechanism. A group of standard

Units normally covered



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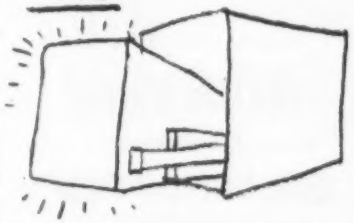

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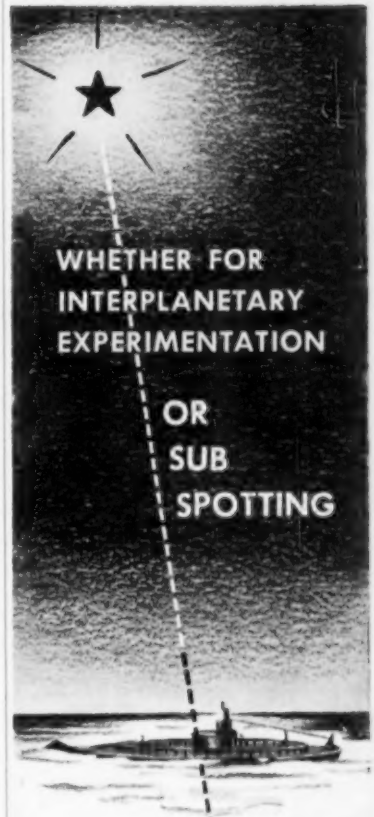
models are available in assemblies for 40 to 120-cps operation. They are of the low residual noise type with top connected driving coils. Various models are offered with different contact closures. The l-f choppers described are excellent for instrumentation, computers and other precision applications. They also feature resistance to temperature, shock and vibration extremes. The second group of h-f choppers discussed will operate from 50 to 550 cps.

Transformers. Moran Electronic Components, Inc., 10502 Wheatley St., Kensington, Md., has available literature on its standard line of transformers (audio, filament and power), reactors and similar components. An expanded line of power transformers is discussed in 8 pages of new literature consisting of drawings and specifications.

Turret Punch Press. Wiedemann Machine Co., 4272 Wissahickon Ave., Philadelphia 32, Pa. Bulletin 242 describes the RA-4P turret punch press for punching holes in printed wiring boards. The machine discussed will punch holes at a rate of 80 to 120 per minute and handles boards up to $\frac{1}{8}$ in. thick. The first board of a lot is drilled to its etched layout and used as the template to complete the run. Holes are pierced as rapidly as the operator can depress a stylus point into color coded holes in the template.

Pulse Transformers. Berkshire Laboratories, 506 Bank Village, Greenville, N. H. Types PT-1, PT-2 and PT-3 plug-in type pulse transformers are covered in a loose-leaf perforated catalog sheet. Uses, advantages, diagrammatical specifications, characteristics and prices are given. The descriptive sheet is obtainable on request.

AN Connectors. The Deutsch Co., 7000 Avalon Blvd., Los Angeles, Calif. Bulletin PN-1 covers the company's complete line of AN electrical connectors. It briefly describes the fields of application, and provides general information on performance requirements, size and capacity, basic parts and the



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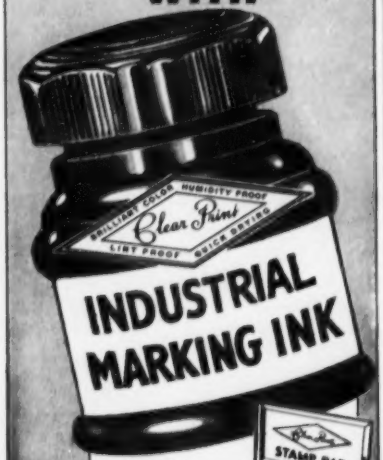

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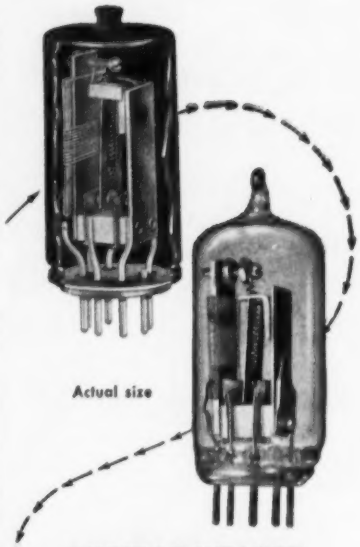
numbering system used. A detailed description is presented on the shell construction for wall mounting, cable-connecting and box mounting receptacles—straight, solid shell and 90-deg angle, split-shell plugs. Another section provides information on the inserts, which have an arc resistance of approximately 140 seconds, dielectric strength of 180 v and a post-mold shrinkage of only 0.001 in. per in. Installation instructions for the various types of shells are illustrated with assembly and disassembly drawings.

Color TV Microwave Relay. Raytheon Mfg. Co., Waltham, Mass. Bulletin 3-110 describes the KTR-100 system of color tv microwave relaying. The KTR-100 provides a one basic system for both color and monochrome transmission with built-in multiplexed audio signals and can be used as either a permanent or portable link for stl and remote pickups. It is adaptable to all bands. The literature gives data on applications, performance, specifications and accessories.

Analog Computers. Mid-Century Instrumatic Corp., 611 Broadway, New York 12, N. Y. A 16-page brochure describes the company's analog computers and allied equipment. Included are facts, specifications and photo reproductions of the MC-300 six-channel recorder; MC-400 analog computer; MC-500 d-c analog computer; MC-600 six-channel electronic function generator; and MC-700 a-m/f-m electronic multiplier. The Dian computing service is also discussed.

Delay Lines. E. S. C. Corp., 534 Bergen Blvd., Palisades Park, N. J. A new catalog now available describes the latest in delay lines, variable delay lines and pulse forming equipment.

Relays for Carrier Equipment. Lenkurt Electric Co., San Carlos, Calif. Volume 4 No. 7 of the "Demodulator" shows some types and applications of relays used in carrier equipment. Also included, for those who wish to purchase carrier or radio equipment on a completed project basis, is information on



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Single pole, double throw contact action eliminates chatter. These unique relays feature snap action, double throw, reliability, small size. They are adaptable to military and commercial applications. Time delay periods: preset from 3 seconds up. Envelope: metal, miniature (7 and 9 pin) or octal (8 pin). Glass, 9 pin only.

High-Low Differential Thermostat

The "SNAPPER" Thermostat is a single pole, double throw snap action temperature sensitive switch. Its snap action principle has been extended to provide a low differential thermostat with precision characteristics, at low cost.

Write for detailed data

ELECTRONICS DIVISION

CURTISS-WRIGHT

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the "Engineer, Furnish and Install" service.

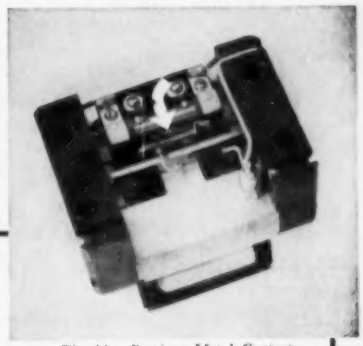
Photoelectric Press Control. Champlain Co., Inc., 88 Llewellyn Ave., Bloomfield, N. J. An electronic system that automatically controls cutoff and color register on high-speed web-fed presses and other rotary printing equipment is described and illustrated in a new 4-page bulletin. Two models of the Registron are discussed, with the principal components of each model listed. Basic units of the system described consist of a web scanner, photoelectric phase detector and automatic control panel. Eight photographs illustrate various components of the system. A block diagram, which outlines the electronic circuit for the automatic register unit, is also included.

Recording/Reproducing Heads. The Davies Laboratories Inc., 4705 Queensbury Road, Riverdale, Md. Bulletin 55-B gives complete information on multitrack magnetic recording and reproducing heads featuring adequate intertrack shielding and precise gap alignment. Designed and manufactured specifically for data recording applications, the heads described provide improved data reproduction. The heads are available for direct, f-m, or digital recording with a maximum width of 2 in.

Contact-Meter Relay. Assembly Products, Inc., Chesterland, Ohio, has available bulletin G-6 (which includes circuitry bulletin 112) on automatic contact meter-relay control with electromagnetic locking contacts. Applications for lab and industrial use are given. Specifications, ordering information and prices are included.

Magnet Wire Catalog. The Electric Auto-Lite Co., Wire and Cable Division, Port Huron, Mich. The newly revised magnet wire catalog includes all current magnet wire applications manufactured by the company; tables on diameters, tolerances, and physical and electrical properties of the various wires; inspection and testing facilities; and a new section covering thermal classifications of available insulations.

NEY'S small parts play a BIG part in precision instruments



The Ney Precious Metal Contact (indicated by arrow) is an important part of this Genisco Accelerometer.

Genisco Accelerometers are used in the guidance systems of missiles now in large-scale production. They are rugged, potentiometer-type instruments chosen for their reliability and precise performance. For the double-contact wiper of the potentiometer, Genisco selected Ney's Precious Metal Alloy Paliney #7* because it provides the important advantages of holding noise at a minimum, excellent linearity, long life and satisfactory performance in temperatures from —65° F. to +200° F.

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Plants and People

Edited by WILLIAM G. ARNOLD

Engineers and executives in the industry are promoted and move to new responsibilities. Manufacturers continue plant and facility expansions by acquisitions and new construction. Industry associations and technical societies announce new activities

RETMA Streamlines Organization, Hears Air Force Chief

AT THE final business session of its three-day convention, RETMA amended several of its by-laws to streamline the Association to better serve the member-companies. The by-law amendements revised the dues schedule and provided for greater fiscal autonomy within the several divisions. Members authorized the establishment of a military products division.

Members also approved the consolidation of the former amplifier and sound equipment division as a section within the technical products division. The RETMA board abolished the former radio-television industry committee and the electronics industry committee and reduced its own membership from 62 to 41, including the treasurer and director of the engineering department. The board also eliminated all honorary directors and directors-at-large.

Lt. Gen. C. S. Irvine (center), Deputy Chief of Staff, Materiel Headquarters, U. S. Air Force, spoke on the weapon system concept of procurement at a luncheon session during the 31st annual convention of RETMA. Left is Max F. Balcom, director-consultant, of Sylvania Electric and former chairman of the RETMA Board of directors. To the right is Fred R. Lack, vice-president of Western Electric and RETMA vice-president representing the military products division

The division chairmen are as follows:

Set division—H. C. Bonfig, president of CBS-Columbia; tube division—R. T. Orth, vice-president of Westinghouse electronic tube division; parts division—Herbert W. Clough, vice-president of Belden Manufacturing Co.; technical products division—James D. McLean, vice-president of Philco's industrial division; military products division—T. A. Smith, vice-president of RCA's engineering products division.

Total RETMA membership stands at 389 companies.

Du Mont Ups Engineers, Builds West Coast Plant

A NEW technical products division has been formed by Allen B. Du Mont Laboratories.

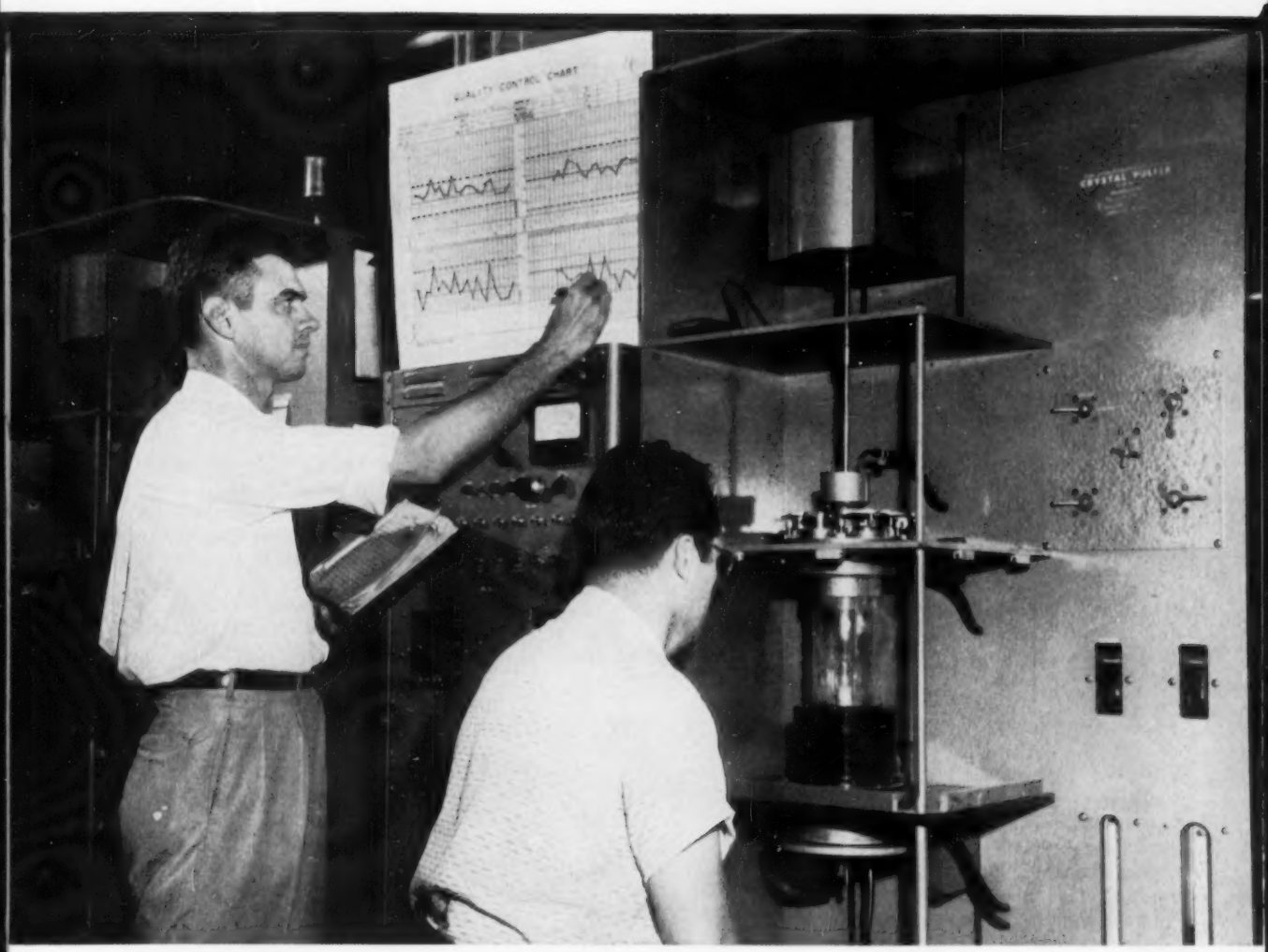
The new division will be headed by P. S. Christaldi and will manufacture and sell the products formerly handled by the company's instrument division and communication products division. It is initiating a program of expansion and diversification with especial emphasis on elements and systems for automation of industrial processes.

Over-all administration for technical products is conducted by vice-president Irving G. Rosenberg, whose responsibility encompasses both the new technical products division and the government manufacturing division.

Dr. Christaldi has been associated with Du Mont since 1938. His first duties were in the field of cathode-ray tube and cathode-ray oscillograph development, being expanded to include television receiving and transmitting operations when he was appointed chief engineer of the firm in 1941. In 1947 he became engineering manager of the instrument division. He was made assistant manager of the division in 1952 and manager in 1953.

Robert E. Kessler has been named general manufacturing manager for the technical products division.

As general manufacturing manager he will supervise the engineering department headed by A. J. Talamini, the production control department headed by Morris Harris, purchasing headed by C. P. Martin, manufacturing which is headed by R. E. Svozil and inspection



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You can now design transistorized circuits to standard device specifications. Texas Instruments *controlled parameter* semiconductor devices fit your specific applications without additional testing and selection. Parameter tolerances are closely held and accurately described in new comprehensive design data. All TI germanium and silicon transistors are manufactured and 100 per cent tested for exacting design characteristics.

This close parameter control has enabled Texas Instruments to pace the industry in transistor development and application. Newest TI germanium devices are n-p-n high speed switching transistors. An important step toward complete transistorization of computers, these grown junction units have beta spreads of two-to-one and are 100 per cent tested for switching characteristics. TI was also first to produce silicon transistors commercially, and *only* TI manufactures germanium transistors for *all* three transistorized pocket radios now on the consumer market. For radio, general purpose, and many specific applications, Texas Instruments manufactures both p-n-p alloyed junction and n-p-n grown junction germanium types.

For your own transistorized product development, specify the exact devices you need from TI's wide range of semiconductor products — germanium and silicon; p-n-p or n-p-n types; diodes, triodes, tetrodes. Write for new descriptive data and curves that will help simplify your production problems.

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- ☐ P-N-P alloyed junction general purpose transistors
- ☐ N-P-N grown junction general purpose transistors
- ☐ Phototransistors
- ☐ Grown junction tetrodes

SILICON

- ☐ General purpose transistors
- ☐ Power transistors
- ☐ Junction diodes
- ☐ Voltage reference diodes

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headed by D. M. Christie.

Immediately prior to this appointment, Kessler had served as manager of the communication products division. His background with the company goes back to 1936. He was the ninth full-time employee to be hired by Dr. Allen B. Du Mont.

G. Robert Mezger has been named general sales manager of the technical products division. He will supervise the television transmitter sales department headed by J. B. Tharpe, the mobile communications sales department headed by Fred M. Link and the technical sales department headed by Emil G. Nichols. Immediately prior to his new appointment, Mezger was assistant manager of the instrument division.

P. S. Christaldi

Robert E. Kessler

Du Mont also announced that a new building, containing approximately 30,000 sq ft of floor area is under construction in Los Angeles. It will fill the firm's need for more space and facilities to handle west coast electronics commitments and sales both for military and industrial purposes.

Ground has already been broken for the new building, and it is anticipated that occupancy will be possible during October of this year. Du Mont's west coast manager is Ralph B. Austrian, who will make his offices in the new building. The plant is also available for the cathode-ray tube division.

DeVore Joins Stewart-Warner As Electronics Head

LLOYD T. DEVORE, who has been manager of the electronics laboratory of GE since 1950, has been named general manager of the electronics division of Stewart-Warner Corp. The firm plans to step up its development and production of electronic products.

During World War II, Dr. DeVore was chief engineer of the special projects laboratory for the Army Air Forces at Wright Field, and was awarded the War Department Exceptional Civilian Service Medal in recognition of his achievements at the lab.

Lloyd T. DeVore

He was assistant professor of physics at Pennsylvania State College and professor of electrical engineering at the University of Illinois, where he also was chairman of the research committee and coordinator of research for the electrical engineering department of the university.

Stewart-Warner also announced that an agreement has been signed for the purchase of John W. Hobbs Corp., producer of specialty devices and equipment.

Hodgson Promoted By Fairchild Camera And Instrument

Richard Hodgson

RICHARD HODGSON has been elected a vice-president of Fairchild Camera and Instrument Corp. He has been promoted from the position of trend planning director to that of general manager of the company's reconnaissance systems division.

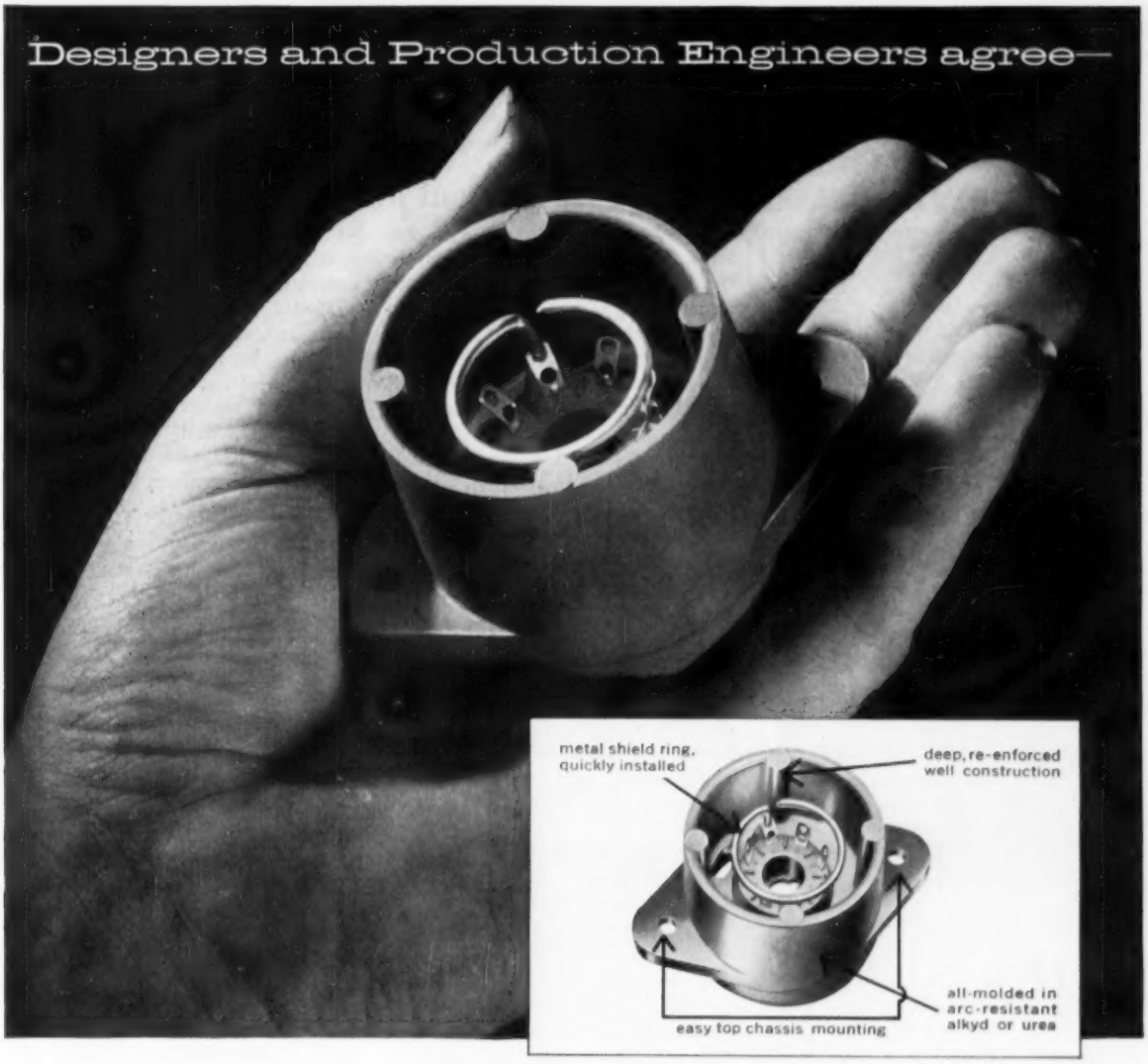
Hodgson was one of the organizers of Chromatic Television Laboratories, developers of Lawrence color television picture tubes. He was president of the firm until he joined Fairchild, and continues to serve on the board of directors.

He has been director of television development for Paramount Pictures, assistant treasurer of Du-Mont Laboratories, head of the engineering management division of Brookhaven National Laboratory, senior change board engineer for Lockheed Aircraft and a manufacturing and process economic analyst for Standard Oil of California.

Olympic Radio and Victoreen To Merge

PLANS have been made for the merger of Victoreen Instrument and Olympic Radio into a new corporation, Nuclear Electronics. David H. Cogan, chairman of Victoreen, is to be president of the new firm with C. W. Haller and Morris Sobin,

Designers and Production Engineers agree—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all-molded in arc-resistant alkyd or urea
easy top chassis mounting

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H-V ANTI-CORONA OCTAL SOCKET

—pays for itself in performance

As a designer, you'll find Sylvania's all-molded H-V anti-corona socket increases the efficiency of high-voltage circuit design—your product gives better, longer, trouble-free performance in the field.

Production engineers will say it cuts down production snags and expensive after-assembly "tailoring" to eliminate corona problems.

Whatever the nature of your electronic equipment, if high voltage circuits tend to exhibit corona problems, this is the socket for you. It's doing the job where other anti-corona measures prove inadequate.

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1. Production sampled daily and life tested to check 1,000 hour rating.
2. Every Chopper given not only one but two tests over the full range of military temperatures before shipment.
3. Only gold contacts used for superior operation in the vital 0-1½ volt d-c range.
4. Liberal safety factors to meet emergency conditions.
a. 0-500 cps.
b. Input voltage ±30%.

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presidents of Victoreen and Olympic respectively, as vice-presidents of Nuclear.

Last year Victoreen reported sales of $1.5 million and a net loss of $1.9 million. Olympic had 1954 net sales of $18.3 million and net income of $256,836.

General Instrument Merger Set

GENERAL Instrument Corp. has acquired Automatic Manufacturing Corp. of Newark, N. J., and elected an enlarged 11-man board of directors, which immediately moved to combine the executive forces of the two companies. Martin H. Benedek, president of Automatic Manufacturing, becomes chairman of the board of General Instrument and chief executive officer. Moses Shapiro, executive vice-president of Automatic, has been named to the same position at General Instrument, a newly-created post for that company.

Monte Cohen, president of General Instrument was reelected to his post by the new board. Alois Konecny, Jr. and Louis Scadron continue as treasurer and secretary, respectively, and C. F. Sullivan and L. S. Grossman as assistant secretaries. Abraham Blumenkrantz was elected chairman of the finance committee.

Division Becomes Barnes Engineering

BARNES Engineering Co. is the new name of Olympic Development Co. of Stamford, Conn. Although formerly established as the development division of Olympic Radio & Television Co., it is now an independent engineering and manufacturing company, with R. Bowling Barnes as president.

The company is engaged in the development and production of infrared components and instrumentation for remote temperature measurement and control.

It also manufactures automatic assembly machines, through Multra Corp., a wholly-owned subsidiary and owns Clarksburg Television Cable Corp. which operates a community antenna system.

Charles J. Burton will continue to serve as vice-president and treasurer of the company.

The directors of the company, in addition to Dr. Barnes and Dr. Burton, are: Heywood Fox, general partner of Fox, Wells and Co., a private investment firm; James G. Rogers, Jr., an associate of Fox, Wells and president of KFSD of San Diego, Calif., and Glen McDaniel, general counsel of RETMA.

R. Bowling Barnes

Other members of the executive and technical management group of Barnes Engineering are Eric M. Wormser, chief engineer of the infrared division; Donald M. Frothingham, chief engineer of the Binotrol division; Frank K. Lake, chief engineer of Multra Corp. and W. Randolph Tucker, president of Clarksburg Television Cable Corp.

Assembly Products Builds Desert Plant

NEAR Palm Springs, Calif. on 120 acres of the desert, a manufacturing plant for Assembly Products is being built. Instruments for measurement and control in industry will be assembled in small buildings of 1,500 to 5,000 sq ft, each designed and built for the type of work to be done in it. Residential lots of one to three acres will be made available to employees who want to build homes on the desert. Construction has been started on a factory building, two residences and a swimming pool. These are scheduled for completion by September 1st. The first factory building of 1,500 sq ft will be used for an office and de-

velopment laboratory.

Several months of design and experimental testing will proceed any actual production in the desert plant. Bill Hotine, a relay and electronic engineer, has been employed to manage this research and development. For several years he has done product design on instruments and controls—most recently with Fairchild Camera Co. He holds several patents on contacts and assemblies for relays.

Westinghouse Names Computer Head

V. B. BAKER has been appointed to the newly created position of assistant engineering manager, executive department, East Pittsburgh divisions of Westinghouse. He was formerly with the firm's engineering headquarters staff.

He will have primary responsibility for developing and coordinating engineering applications of electronic computers in the East Pittsburgh divisions. He will report directly to the engineering manager. He joined Westinghouse in 1939.

Schultz Heads Nuclear Group

M. A. SCHULTZ of Westinghouse Electric has been elected chairman for the coming year of the administrative committee of the IRE professional group on nuclear science.

Minnesota Mining Promotes Two

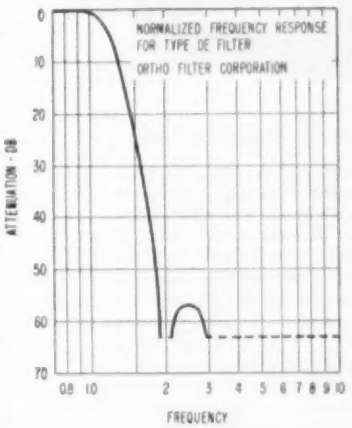
ROBERT A. VON BEHREN has been promoted to research and development manager of the magnetic products division of Minnesota Mining & Manufacturing Co. Andrew H. Persoon has been named chief chemist of the division's laboratory.

Since 1953 von Behren has been assistant technical director of magnetic products. He joined 3M in 1948 as a quality control engineer and was made technical service supervisor in 1951.

Persoon has been a section leader in the magnetic products laboratory since 1953. He joined 3M in 1943 as a chemist in the tape laboratory. He was made products engineer of

DISTORTION ELIMINATOR

For Eliminating Harmonics of a Signal



The Ortho Filter Type D.E. Filter provides a means for eliminating harmonics from a complex wave. Standard filters are readily available for use with any fundamental frequency from 20 cps to 2000 cps. The filters are available for use over a wide range of impedances. Specify the nominal impedance when ordering.

For further information write for the following bulletins:

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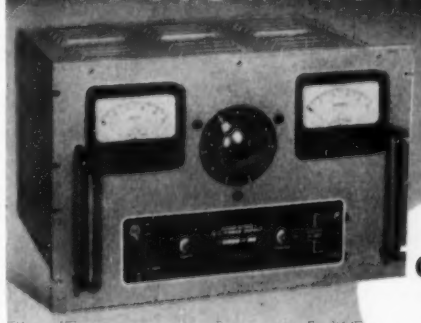

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- Delay type overload protection.
- Permanently etched control designations.
- Over-current warning indicator.
- Stepless output control.
- Compact, portable design.
- Zero maintenance.

ADDITIONAL SPECIFICATIONS:

OVERLOAD:	400% for ½ minute, 200% for 2 minutes.
REGULATION:	D.C.V. at Full Load: 28.5. D.C.V. at 1/10 Load: 33.
CONTROLS:	Power switch, voltage control, pilot light, overload warning light.
TERMINALS:	Panel binding posts plus rear terminal board.
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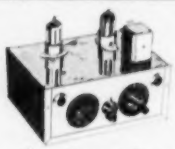
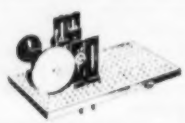

electronics


mechanical devices

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the magnetic products laboratory in 1948.

Beckman Instruments Buys Liston-Becker

BECKMAN Instruments purchased the Liston-Becker Instrument Co. of Springdale, Conn., manufacturer of infrared gas analyzers and electronic amplifiers.

Last year Beckman acquired the Specialized Instrument Co. of Belmont, Calif., manufacturer of ultracentrifuges used in successful isolation of polio virus.

Max D. Liston, founder of the company, will continue as manager of Liston-Becker operation. No change in personnel or plant location is contemplated.

Phillips Control Names President

JOHN W. AYERS has been named president of Phillips Control Corp. of Joliet, Ill., a wholly-owned subsidiary of Thor Corp.

Ayers, who has been vice-president in charge of engineering for Phillips for the past 3 years, replaces John Mossman, resigned.

Gregory J. Oehmen, formerly assistant to the president of Phillips, was appointed to the post of general manager.

Budd Selects Fibre Division Heads

MEMBERS of the board of Continental-Diamond Fibre division of the Budd Co. include E. G. Budd,

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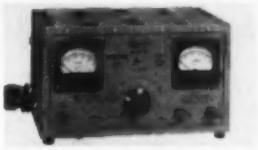
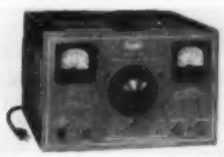
in guided missiles . . . electronic equipment, radios, for aircraft, autos, tanks, marine craft . . . laboratory work of many kinds . . . operating low voltage devices.



NEW Model "EF" dual range $84.50
0-28 v up to 5 amps, 0-14 v up to 5 amps

Only dual range unit with all these features at this low price on the market. Certified proof of less than 1% AC hum at maximum load furnished with each unit. High quality construction and components. Intermittent loads up to 10 amperes. Single-knob control —easy continuous voltage adjustment as load changes. Special conduction cooling gives 25% extra current capacity. *Write for Bulletin EFCS.*



Model "NF" heavy duty $195.00
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Widely recognized and accepted in industry as the heavy duty unit of unmatched construction and performance for this low price. Intermittent loads up to 25 amperes. Certified proof of less than 1% ripple at top load. Single control gives continuous voltage adjustments. Patented EPL conduction cooling for long life, 25% more power. *Write for Bulletin NF252.*

NEW Model "GF" heavy duty
0-125 v up to 10 amps

Capable of servicing most DC equipment from AC lines. 20 amperes intermittent rating . . . less than 1% ripple at top load certified. Bridge-type rectifier, plus forced air cooling. Voltage control over entire range. *Write for Bulletin GF.*

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who will also be president of the subsidiary; H. A. Coward and E. R. Schmidt, executive vice-presidents; Harry K. Collins, vice-president; G. E. Lallou, secretary and treasurer and E. E. Reardon, controller.

As vice-president and general manager, Collins will be the chief administrative officer of the new company. He will be assisted by J. Franklin Anderson and Ernest O. Hausmann, vice presidents. W. H. Walker will be purchasing manager; A. H. Haroldson, research and development manager; H. M. Dexter, general sales manager; J. Paul Jacquette, assistant secretary and assistant treasurer; Worth Tracy, employee relations manager; Martin J. Gauger, assistant controller and L. K. Winter, export sales manager.

Russell Sylk and Marvin C. Cain will continue as plant managers of the Newark and Valparaiso plants. George Kennedy will continue as acting plant manager of the Bridgeport plant.

Ampex Promotes Instrumentation Head

ROBERT SACKMAN, manager of the instrumentation division of Ampex Corp., has been elected an officer of the company.

Prior to assuming his new duties, Sackman was manager of Ampex's Washington, D. C., district office. He joined Ampex in 1953, after serving as the chief of a government research and development group with the Department of Defense. Previously, he was a civilian engineer for radar beacon and ground control approach development with the U. S. Navy. While with the Navy, he also established a laboratory for test and calibration of low frequency quartz crystals.

GE Expands Tube Facilities

A 112,000 sq ft plant costing $1.2 million, needed primarily for expansion of the receiving tube warehousing and engineering development facilities, is planned by GE at Owensboro, Ky. Sections of present production facilities at Owensboro will be moved to the new plant to

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Continuously tunable CW, sweep or pulsed RF output.
0.25% frequency accuracy and stability.
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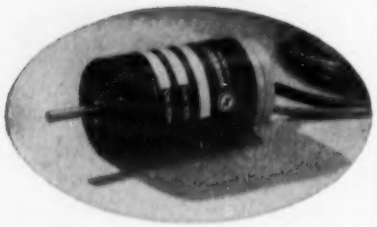
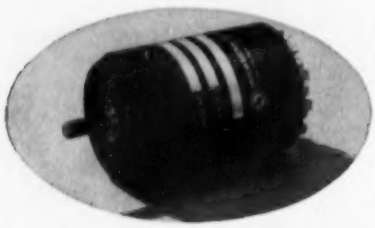
EQUIVALENT
SIZE 11
PRECISION INDUCTION
RESOLVER!

Available Immediately!



SIZE 11—Mark 4 Mod 0 Electrical Equivalent, Winding Compensated
Frame Size: 1.062"
Functional Error less than 0.1%
Perpendicularity: less than ±5 minutes



SIZE 15—Mark 4 Mod 0 Equivalent with accuracies and phase shift better than specified!

SIZE 23—Exceptionally high functional accuracy—better than .05%. Perpendicularity better than ±3 minutes.

ALSO AVAILABLE—All American Electronic SIZE 11, 15 and 23 Resolvers may be obtained with: HIGH IMPEDANCE NETWORK COMPENSATION, PARTIAL OR COMPLETE WINDING COMPENSATION, BROAD BAND, HIGH FREQUENCY RESPONSE.

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Engineering Representatives in all Principal Industrial Areas

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permit 50,000 sq ft of leased warehousing space to be relinquished.

Ground breaking is scheduled for August and occupancy is planned for shortly after the first of 1956.

Stromberg-Carlson Appoints Wilson

DONALD GREY WILSON, chairman and professor of the department of electrical engineering, University of Kansas, has been appointed assistant director of research at Stromberg-Carlson Co. In this new position, Dr. Wilson will be responsible for coordinating organization functions and activities, development of personnel, guidance in budgetary control, and the coordination of the public relations activities of the re-research organization at Stromberg-Carlson.

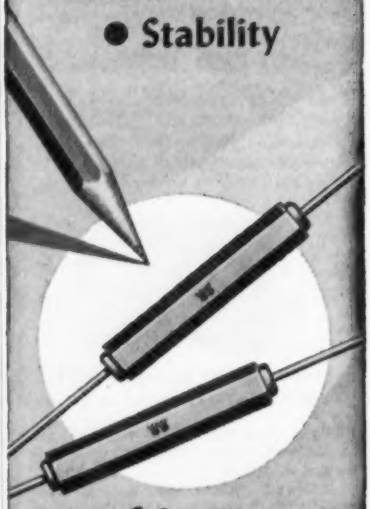
Prior to joining the department of electrical engineering at the University of Kansas in 1947, where he served as assistant professor, professor, and department chairman, he had broad experience in business and research at the Sealand Corp. automatic fire alarm division; instructor in electrical engineering at Rensselaer Polytechnic Institute and staff member at the MIT radiation laboratory.

Chicago Standard Changes Officers

WILLIAM J. SHEA, who has been chairman of the board and chief executive officer of Chicago Standard Transformer will assume the office of president due to ill health of president Larry S. Racine.

In Racine's absence, Donald Schwennesen, vice-president in

● Low noise level
● Precision
● Stability



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MOLDED RESISTORS

RATING—1 watt.

TEMPERATURE COEFFICIENT—From approx. +0.1%/°F for 5000 ohm values to approx. —0.2%/°F for 10 megohm values.

VOLTAGE COEFFICIENT—Rated at less than 0.02%/Volt.

UPPER TEMP. LIMIT—170°F for continuous operation.

NOISE LEVEL—Low noise level inherent, but at extra cost we can test and guarantee standard range resistors with "less noise than corresponds to a resistance change of 1 part in 1,000,000 for the complete audio frequency range."

VALUES
Standard Range—1000 ohms to 9 megohms.
Extra High Value Range—Up to 10,000,000 megohms.

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has full details. Send for a copy. Attention Dept. R.

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DENTAL MFG. CO.
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NEW YORK 16, N. Y.
Western District Office • Times Building, Long Beach, Calif.

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charge of engineering, will be vice-president in charge of sales and engineering.

Ray Gislason has been appointed vice-president in charge of all manufacturing plants of the company.

Bonfig Named CBS-Columbia President

HENRY C. BONFIG is president of CBS-Columbia, succeeding Seymour Mintz, resigned.

He is also a vice-president and director of CBS, the parent firm.

In 1935 he was named commercial vice-president of RCA Victor, a position he held until 1944.

In 1944 he was appointed vice-president and director of sales for Zenith Radio Corp.

He remained with Zenith until May, 1955 when he accepted the presidency of CBS-Columbia.

Burroughs Takes On More Space

BURROUGHS CORP. has acquired a one-story building in Detroit for production of classified electronic equipment. The building contains 104,000 sq ft of floor space and is located on a 23 acre site. The new operation is expected to employ nearly 1,000 persons.

New Computer Center Established

A NEW analogue computing center has been established by Dian Laboratories in New York, N. Y.

Dian is affiliated with the Mid-Century Instrumatic Corp. The computing services are available to government and industry on a rental basis. The firm is also en-

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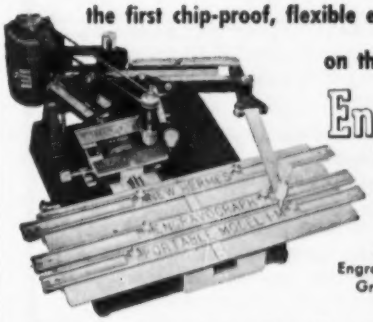

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For Every IMPORTANT FASTENING

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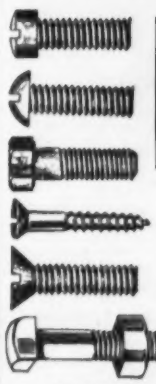

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Original designers and manufacturers of Synthetic Dielectric Capacitors. We use plastic film dielectrics exclusively in our products. Where Size, Stability and Quality are essential, you can depend on Condenser Products.

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"Pyrex" glass encased, plastic film dielectric, temperatures to 125°C. Insulation resistance to 10,000 meg x mfd. Types for DC and RF applications.

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Voltage ranges from 600V DC to 100KV DC or higher. Temperature characteristics to suit.

HI-VOLT POWER SUPPLIES

Available from stock: 2KV, 5KV, 10KV, 15KV, 30KV, 50KV. Oil-filled construction for smaller, lighter, more flexible units. Separate accessible compartment for rectifier tubes in 50KV model. Also available in the 5KV, 10KV, 15KV, and 30KV power supplies.

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Synthetic dielectrics for higher volt per mil loading and lower losses in capacitor dielectric. Stable performance at high temperatures. Ranges to 60KV. Designed to meet your requirements.

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Condenser Products Company
Div. of New Haven Clock & Watch Co.
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gaged in the design of simulators, trainers and special-purpose computers.

Its staff is headed by Dr. Stanley Fifer, former head of the Navy Project Cyclone and member of the technical staff of Hughes Aircraft Co.

Gulton Appoints Two Engineers

SAMUEL HANISH has been appointed head of the underwater sound division of Gulton Mfg. Corp. of Metuchen, N. J.

George M. Hieber has been placed in charge of the development of electromechanical instruments for the firm. He previously handled field and development engineering.

Hanish joined the organization last year as a research engineer in its shock and vibration department, coming from Power Generators of Trenton, N. J., where he specialized in dynamic analysis in mechanical systems. He will be engaged in the evaluation and development of new transducer materials for underwater sound techniques, development of transducers for commercial underwater sound applications, and design of complete sonar systems and industrial control equipment.

Heiber, prior to joining the company, was a stress and instrumentation specialist with Grumman Aircraft.

Waddell Joins Giannini Division

BILL L. WADDELL has joined Datex division of G. M. Giannini & Co. as senior systems development engineer, charged with design and development of digital data handling systems. He formerly was with Northrop Aircraft and Librascope in computational analysis and systems development.

Canoga Expands Plant Facilities

CANOGA CORP., manufacturers of radar systems, antennas and other devices, has acquired a 10,000 sq ft building, adjacent to the antenna range of its present facilities in Van Nuys, Calif. Overall invest-

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components
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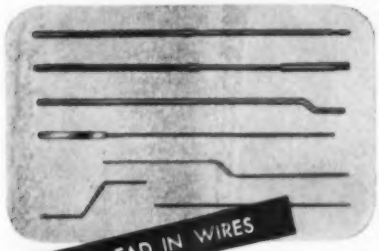

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The Engineering Company can give you immediate delivery on following bases: 50 Watt, 3303B, 412 Industrial Base, Giant 7 Pin Bayonet, 4310 Four Pin Jumbo, Tetrode, Hydrogen Thyratron Bases in both Aluminum and Copper up to 6.50 dia. etc. All bases to JAN-1A/MIL-E-1B and subjected to weights and strength tests.

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ment for the land, building and equipment was around $200,000.

The new addition, expected to increase production by 50 percent, will house the expanded electronic, microwave, and mechanical engineering departments.

The company anticipates the addition of another building of similar size in about a year.

Bogue Electric Elevates Gerlach

KEN R. GERLACH has been appointed executive vice-president of Bogue Electric Manufacturing Co., of Paterson, N. J. He was with the Sperry Gyroscope Co. with experience in the application of precision motor-generator equipment.

Prior to joining Sperry, Gerlach was associated with the Colonial Radio Co.

Mid-Century Names Chief Engineer

NELSON A. Merritt has been appointed chief engineer of the Mid-Century Instrumatic Corp. of New York City.

The firm manufactures electronic precision analogue computers and computing equipment. Merritt will supervise the design of new products and will be in charge of engineering in connection with the manufacturing of all products.

He previously was head electronics engineer of the Electric Boat division of General Dynamics Corp. He was responsible for the

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nuclear reaction control systems on the USS Nautilus, first atomic submarine.

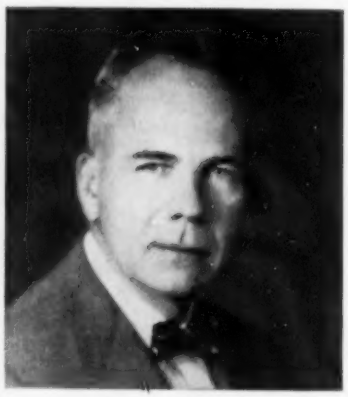
Edison Elects Vice-Presidents

DONALD W. COLLIER and Charles Howe Goddard have been elected vice-presidents of Thomas A. Edison.

Dr. Collier will continue in his present capacity as director of research, a post he has held since June, 1951.

Goddard will continue his activities as assistant manager of Edison's Voicewriter Division. He joined Edison in May of this year. He was formerly with Sylvania Electric Products for 11 years serving as marketing manager of the lighting division.

Viking Instruments Selects Martin



VIKING Instruments of East Haddam, Conn. appointed Devereaux Martin as vice-president and director of engineering. He will direct development and research on the company's line of electronic devices and controls for industry.

He was formerly assistant to the president of Electronics Corporation of America.

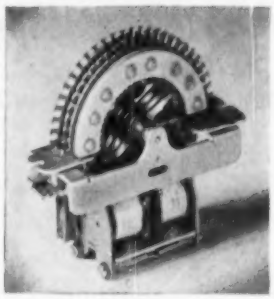
Brubaker Appoints Quality Manager

CHARLES R. WILSON, JR. has been promoted to the position of manager, quality control, at Brubaker Electronics, of Los Angeles.

Wilson has, for the past four

TWO-WAY STEPPING SELECTOR

For Computing, Control, and Indicator Systems



The flexibility of forward and reverse stepping at the operator's choice, or by automatic cycling, is now obtainable in a compact unit—the G.E.C. two-way stepping selector. Each of these units can replace several conventional one-way stepping relays, thus adding efficiency and versatility to circuit design.

The G.E.C. two-way stepping selector operates in either direction at a speed of approximately 65 steps per second on self-interruption, and at speeds up to 20 steps per second from external impulses. Positive stepping action and freedom from over-stepping are assured by driving the wiper assembly on the forward stroke of the appropriate armature.

The unit is designed for use with standard 25-contact banks, up to three levels. All selectors can be supplied with bridging or non-bridging wipers, or any desired combination of both. The armature coils can be supplied for operation at 12, 24, 50, 110 or 220 volts d-c. Bank contacts, wipers, and wiper brushes are of nickel silver for maximum life. The interrupter springs, designed for easy adjustment, are fitted with platinum contacts. The finish of the units makes them suitable for either standard or tropical use.

One-way stepping selectors with standard 25-point banks up to 8 levels, or 50-point banks up to 5 levels, in either standard or heavy-duty construction, are also available.

•

For bulletin and prices write: General Electric Company, Limited, c/o IMTRA CORPORATION (U. S. Agents), 58 Charles St., Cambridge, Massachusetts, U. S. A.

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years, served as plant superintendent for the firm. In his new position, he will report directly to the head of the manufacturing division.

Teletronics Names Assistant Chief Engineer

TELETRONICS Laboratory appointed Henry Schwiebert as assistant chief engineer of the company. He was formerly the assistant chief engineer of Wheeler Laboratories and prior to that held the position of project engineer with Hazeltine Electronics Corp.

Gruen Watch Fills Three Positions

GERALD C. Schutz was named as director of electronics of Gruen Watch and Adrian Jacobs and Erwin Kaestner as administrative staff assistant and technical staff assistant, respectively, to Arthur Hansen, executive vice-president.

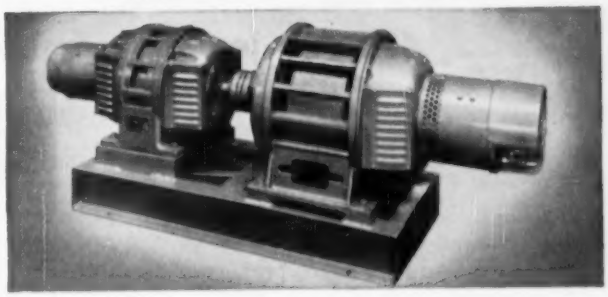
Gerald C. Schutz

Schutz was formerly associated with the Gibbs Manufacturing as director of electronics. During his five years with the firm, he was responsible for the initiation of a number of development programs in the airborne radar navigation and countermeasures field.

Jacobs was formerly production manager of Roller Smith Corp., manufacturers of electrical and electronic integrating and measuring instruments. From 1945 to 1954, he was with Bulova Watch as director of planning and sub-contracts.

Kaestner was formerly manager of manufacturing of the Roller

400 cycle High Frequency Power Supplies



This typical 400 cycle High Frequency Generator is available from 1 KVA to 100 KVA. Variable frequency power supplies can be designed with outputs as low as 3 cycles and as high as 2000 cycles.

Hertner also manufactures high frequency motor generators that can be either synchronous motor-drive, induction motor-drive, or direct current motor-drive.

Consult Hertner for your unusual power supply requirements.

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Designed for low capacitance, high insulation resistance, low attenuation—in plastic or rubber insulation to stand severe service

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T-V LEAD-IN CABLES

Made hollow, of pure virgin polyethylene, for maximum efficiency in receiving Ultra High Frequency signals

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These quality cables are made in various constructions, utilizing plastic insulation for both conductors and jacket

SHIELDED INTERCOMMUNICATION

When installation conditions dictate, shielded cables are recommended. Made with internal or external shield—2 and 3 conductors

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Why chance rejects and breakage that add to production costs when you can eliminate these time-wasting "headaches" with Bird complete jewel assemblies — ready to install in your equipment. Bird's many years of precision production mean jewel bearings of the highest quality. These jewels are set according to your specifications by skilled craftsmen, in less time, for less money, and eliminate special set-ups in your plant.
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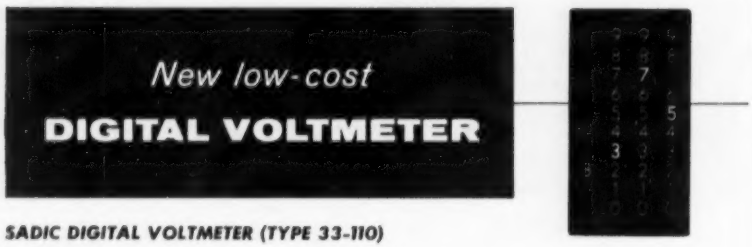

SADIC DIGITAL VOLTMETER (TYPE 33-110) is CEC's newest unit for low-voltage analog-to-digital conversion. It offers true economy plus high accuracy. Output includes illuminated numerical display (above) and decimal-coded contact closures. Suitable for bench use or rack mounting (two units fit side by side in 19" rack) the 33-110 is useful for both laboratory indication and as a building block for automatic data-processing systems.

SPECIFICATIONS

...digital range	000 to 999 (1000 steps)
...accuracy	1/10th % of full scale
...sensitivity	10 millivolts provides full-scale output
...balance time	0.8 second, max.
...power source	105-115 volts a-c

Send for Bulletin CEC 3009-X3

Consolidated Engineering
Corporation
300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service Offices Located in: *Albuquerque, Atlanta, Boston, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, San Francisco, Seattle, Washington, D. C.*

Smith Corporation. Prior to his joining Roller Smith he was chief projects engineer for Bulova Watch on all ordnance projects.

Hermetic Appoints Chief Sales Engineer

HERMETIC SEAL Products Co. of Newark, N. J. appointed A. Neumann as chief sales engineer. He will supervise customer relations, design development and all engineering activities.

Before joining Hermetic, Neumann was associated with IT&T as a process engineer.

Previously, he was development engineer for the Kincaid Manufacturing Co. of New York City.

Mica Fabricators Elect Officers

S. A. MONTAGUE, proprietor of Spruce Pine Mica Co., N. C., was reelected president of Mica Fabricators Association for a second term of one year. Peter J. Yannello of Reliance Mica Co., Brooklyn, N. Y. and John V. Faraci of American Mica Insulation Co., Manasquan, N. J., were elected vice-presidents for the coming year.

Hornickel Selected As Calmag Vice-President

H. C. HORNICKEL has been appointed vice-president and chief engineer of California Magnetic Control Corp., North Hollywood manufacturer of electronic components.

Fischer & Porter Names Four Vice-Presidents

FISCHER & PORTER Co., manufacturers of complete process instrumentation, has promoted four managers to vice-presidents in charge of their respective divisions, bringing the number of vice-presidents to six.

Those named are: Robert A. Stern, vice-president of the data reduction & automation division; Louis H. Aricson, vice-president of the international division; Nathaniel Brewer, vice-president of research; and Edward J. Querner,

vice-president of manufacturing.

The other vice-presidents are Seymour Blechman, vice-president of sales, and Jack C. Boonshaft, vice-president of engineering.

Packard-Bell Fills Manufacturing Post

THEODORE G. EDDY has been named manufacturing manager of the technical products division of Packard-Bell Co. of Los Angeles. The division is chiefly engaged in research and production in electronics and color television.

Before coming to Packard-Bell, Eddy spent five years as an associate with Robert Heller & Assoc., a Cleveland engineering firm, and three years as a field engineer for Albert Ramond Assoc. of Chicago.

Three Firms Join RTCA

THREE NEW members have been elected by the Radio Technical Commission for Aeronautics, increasing the RTCA Assembly membership to 120 organizations concerned with aeronautical telecommunication.

The new members are Flight Safety of Flushing, N. Y.; F-R Machine Works of Woodside, N. Y. and Western Union Telegraph Co. of New York City.

North American Promotes Moore and Ashby

JOHN R. MOORE and Dr. Robert M. Ashby have been appointed to the positions of director and assistant director, respectively, of North American's Aviation's electro-mechanical engineering department.

Moore, who has been assistant director of the department since 1953, joined the company in 1948 as a group leader in the aerophysics laboratory. Prior to that he had been with GE and has served as an associate professor of mechanics and director of the dynamical control laboratory at Washington University.

Dr. Ashby, who replaces Moore as assistant director, came to North American in 1949 from the Naval Research Laboratory Field Station in Boston where he was associate director. During World War II he

Giannini
LOW PRESSURE TRANSMITTERS

Giannini low pressure transmitters utilize a precision potentiometer element to translate pressure signals into proportional electrical signals (20-50 volts), requiring little or no amplification.

MODEL 45176

Models are available with single or multiple outputs, and can be linear with airspeed, altitude, pressure, or to natural or empirical functions.

Ranges from ±0.5 psi., diff. to 0-150 psi., (abs., diff., gage), under normal environmental conditions, or extreme conditions of high acceleration, severe shock or vibration. Write for complete engineering information.

MODEL 45177

G. M. GIANNINI & CO., INC.
AIRBORNE INSTRUMENT DIVISION
PASADENA 1, CALIFORNIA

Giannini

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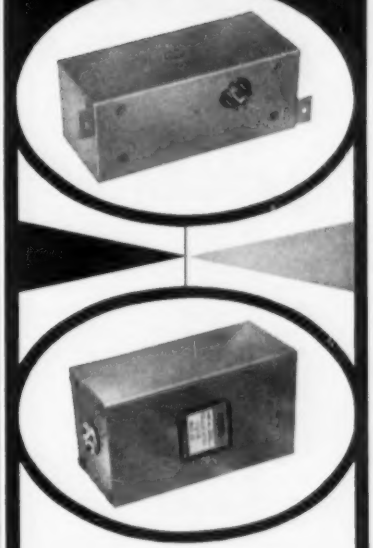
HYCOR
TELEMETERING FILTERS



Features...

- HYCOR telemetering filters have excellent characteristics due to the use of high "Q" toroid inductor elements. The filters may be used in low level circuits with negligible hum pickup resulting.
- In addition, only the finest capacitors are employed to assure stability.
- Available in standard RDB frequencies.

GENERAL SPECIFICATIONS
Impedence 500/500

TYPE	BANDWIDTH	ATTENUATION	FREQUENCY RANGE
1500	±7½%	-3 db or less	400 cps to 14.5 kc
	±20%	-30 db or more	
4300	±7½%	-3 db or less	400 cps to 960 cps
	±20%	-40 db or more	1300 cps to 14.5 kc
4000	±7½%	-3 db or less	400 cps to 960 cps
	±15%	-45 db or more	1300 cps to 14.5 kc
	±15%	-3 db or less	22 kc to 70 kc
	±28%	-45 db or more	

Other frequencies and impedances available on request.

Representatives in Principal Cities

HYCOR Company, Inc.
Subsidiary of International Resistance Company
11423 VANOWEN STREET
NORTH HOLLYWOOD 1, CALIF.

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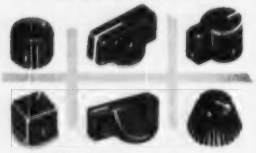
EARN THEIR WINGS IN A TESTING LABORATORY

In recent exhaustive laboratory tests, Plasteck panels subjected to a 150 hour Fadeometer test with competitive panels, surpassed and exceeded required specifications (MIL-P-7788) emerging with no appreciable contrast value change. Thus you are assured of research-developed edge-lighted panels for immediate delivery or for future stock piling.

Our Research and Development engineers are engaged in an untiring effort to develop methods for day and night illumination of instruments and controls in today's military and commercial aircraft. Plasteck provides the industry with a legible panel of high contrast, either laminated or coated to meet your specifications of design.

KNOBS · DIALS



Standard knobs and dials are available in a wide range of sizes and types; specials are made to meet your precise specifications.

3 PLANTS EQUIPPED TO TAKE CARE OF YOUR PANEL NEEDS

Plasteck, Inc.
300-4 S. McKenna Poteau, Okla.
TWX: Poteau 492

California Plasteck, Inc.
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Our engineers and representatives are ready to consult with you at all times. Or write Dept. EL for complete literature on our edge-lighted panels, knobs and dials.

"FIRST IN EDGELIGHTING"

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was a staff member of the Radiation Laboratory of MIT. Prior to his appointment to his new position he was chief of the company's flight and fire control section.

Moore succeeds Dr. Niels E. Edlefsen who has been director of the department since 1951, and has resigned to accept a position as vice-president of another organization.

General Cable Expands

GENERAL CABLE CORP. has entered into a contract for the acquisition of General Insulated Wire Works of Providence, Rhode Island.

C. J. Craig, president of General Insulated, will be appointed a vice-president of General Cable, with principal responsibility for the Providence operation. The newly-acquired plant occupies approximately 100,000 sq ft and employs about 300 people.

General Cable also will construct a new plant in Monticello, Ill. for making paper covered telephone cable. It will occupy some 50,000 sq ft. Formation of a new company to manufacture a complete line of telephone wires and cables in Canada was also announced by the firm. The new company, Telecables and Wires Ltd., will be owned jointly by General Cable, Canada Wire and Cable and the British firm of Telegraph Construction and Maintenance Company Ltd. General Cable will have a substantial minority interest.

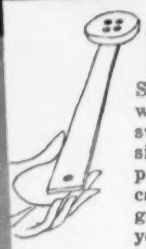
New Printed Circuit Company Formed

EATON ASSOCIATES, a new company, has been organized to manufacture printed circuits and printed circuit assemblies. The new concern, located in Modus, Conn., is already in production.

J. O. Eaton, who was formerly with Eaton Manufacturing Co. of Cleveland, Ohio and Warren Wire Company of Pownel, Vermont, is the principal shareholder in the company. Associated with him in the enterprise are Daniel Dewey of Essex, Conn.; Samuel Pear of Modus; Frank E. Taplin of Williams-

How to whip your relay problems!

Just call **ADVANCE...** *we're ready and willing to make the relays you need.*

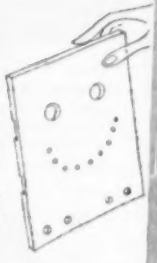


CONTACTS, *for example*

Say the word and we'll up the sizes... switch from fine silver to tungsten, palladium, silver-cadmium oxide, gold contacts, or... you name it!

INSULATION

Laminated phenolic, silicone glass, ceramic steatite, linen-base bakelite, or... you name it!



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ADVANCE will engineer, develop and produce the custom relays you need in minimum time. Call ADVANCE for action.

For **ELECTRONIC USES**

We build a vast variety of sensitive, reliable relays...create superior new designs quickly. You'll find our quality control is now the tightest in the industry.

Write—and let us solve your relay problems

ADVANCE RELAYS

ADVANCE ELECTRIC AND RELAY CO.
An Elgin National Watch Company Affiliate
2435-A NORTH NAOMI STREET
BURBANK, CALIFORNIA

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town, Mass.; A. E. Griffin of Winsted, Conn., and H. D. Randall of Westerly, R. I.

ECA Promotes Senior Physicist

JAY TOL THOMAS has been appointed assistant to the president of Electronics Corporation of America.

Dr. Thomas, who has been serving as senior physicist with ECA, held a similar position for three years with Baird Associates of Boston, and previously worked on process control devices for the chemical industry at the DuPont Experiment Station, Wilmington, Del. In World War II he conducted radar research with the Naval Research Laboratory in Washington, D. C.

Dage Television Names Howland

JOHN R. HOWLAND has been named general sales manager of the Dage television division of Thompson Products.

He will supervise the sale of Dage color television systems and black-and-white television equipment. He formerly headed product research and commercial sales for the electronic division of Stewart-Warner.

Prior to that he was for 11 years assistant to the president of Zenith Radio.

Underwood Plans Plant Expansion

UNDERWOOD Corporation is planning an expansion program including construction of an industrial park containing a new manufacturing plant.

A one-year option has been taken by the firm on a 420-acre tract of land located in Hartford, Conn. If purchased, the area will cost $250,000.

Ransom Research Begins Operations

DAVID H. RANSOM, former president of Mag-Electric Products of Hawthorne, Calif., has established an electronics development and manufacturing firm, under the name

Make a G-M PORTABLE D'ARSONVAL
GALVANOMETER
the Heart of Your Instrument
FOR MEASURING HEMOGLOBIN content of blood samples, the Fisher Scientific Co. of Pittsburgh uses a Model 100 G-M Galvanometer in its popular Electro-Hemometer (at left). Whatever your own particular instrument field, you can achieve this same self-contained portability, ruggedness and high sensitivity with G-M Galvanometers. Complete catalog on request.
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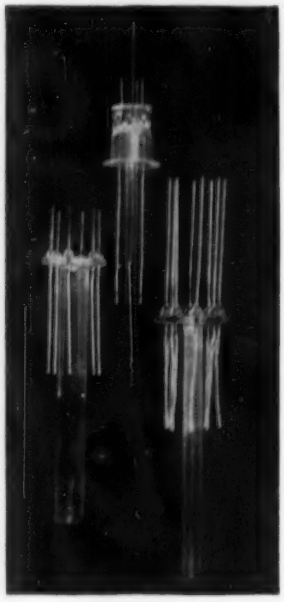


(A)

TUBE COMPONENTS AND HERMETIC SEALS

(A) Molded Button Stems

(B) Powdered Glass Molding

(C) Metal-to-glass Window Seals

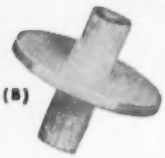
(D) Clear Glass-to-metal Terminals

(E) Chemical-oxide bonded glass-to-metal seals

We are also equipped for custom glass operations, both hand & machine. Complete facilities available for sealing & evacuation. Write now for immediate quotations on any quantity.

(C)

(E)



(B)

(D)

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With Heycos it's no longer necessary to tie wire knots or use insulating grommets. Product life is increased and product appearance is greatly enhanced.

HEYMAN MANUFACTURING COMPANY
Kenilworth 15 New Jersey

HEYCO

Send wire sizes for free samples and specifications.

THE HEYMAN ORGANIZATION WITH 25 YEARS STAMPING EXPERIENCE HAS MODERN PRESS CAPACITY FOR OVER **2,000,000 FINISHED STAMPINGS PER DAY.**

ASK FOR BULLETIN 33

HEYCO

Ransom Research in San Pedro, Calif. Production is underway in the new firm.

Prior to becoming president of Mag-Electric Products, Ransom was director of research and development at Bogue Electric Manufacturing Co., an engineering executive at IT&T and a development engineer at Curtiss-Wright Corp. His work has been in development field of magnetic amplifiers, microwave radio relay systems and telephone switching systems.

Corning Sets Up Parts Department

A NEW department, the components department, has been established in the electrical products division of Corning Glass Works. It will be headed by Forrest E. Behm, formerly manager of pressware plant in Corning.

He will be responsible for the manufacture and sale of various types of glass components.

Mehm joined CGW in 1946 as assistant production superintendent in "A" Factory and later served as production superintendent at pressware plant. He has been manager there since 1953.

Potter Instrument Expands Facilities

POTTER Instrument Co. of Great Neck, N. Y. has expanded production facilities with a new 15,000 sq ft building. The new plant is to be used for expanded production of the firm's magnistors and large data handling systems.

Chemical Firm Studies Selenium Ore

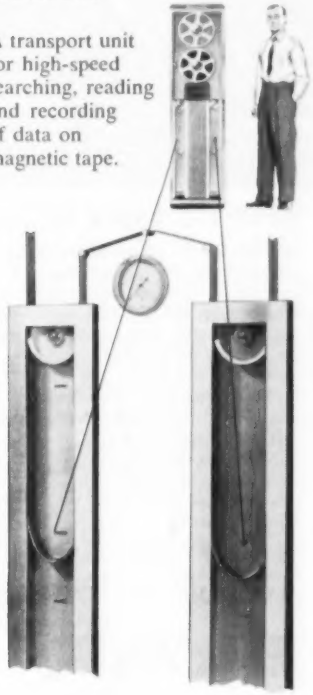
KAWECKI CHEMICAL Co. of Boyertown, Pa., is studying the feasibility of a native selenium ore processing plant in the Lysite area near Shoshoni, Wyo. Selenium is obtained in the U. S. mostly as a by-product from copper processing mills and from flues in refining and smelting plants.

Deposits in the Lysite area contain less than a half pound of selen-

DataReader

Model 546

A transport unit for high-speed searching, reading and recording of data on magnetic tape.



Vacuum column tape control

Vacuum method of sensing provides servo control of the reel drive motors, resulting in a highly sensitive tape feed control. Only a short length of tape need be accelerated to bring the tape to full speed. Exceptionally rapid acceleration and minimum tape strain are realized, since no mechanical system inertia need be overcome.

PERFORMANCE:

RAPID START—STOP—REVERSE—from stop to full speed in 6 milliseconds.

HIGH TAPE SPEED—optional single speed of 30, 40, 50, 60 or 75 in/sec.

TWO-DIRECTION SEARCH—either direction, automatically at full speed.

REMOTE OPERATION—forward, reverse, stop, rewind and selection of reading and writing.

END-OF-TAPE SENSING—stops automatically at either end of tape.

RAPID REWIND—2400 ft. of ½" or ¾" tape in 3 minutes.

FOR FURTHER INFORMATION WRITE
ElectroData Corporation
Component Sales Division
460 No. Sierra Madre Villa
Pasadena 15, Calif.

ElectroData

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CONSOLIDATED ENGINEERING CORPORATION
OF PASADENA, CALIFORNIA
ElectroData Corporation maintains a nationwide sales and service organization.

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ium to a ton of rock.

Preliminary meetings have been held by Dr. Henry Fisk, chairman of the Natural Resources Research Institute at the University of Wyoming; Henry C. Kawecki, president, and Henry E. Sivik, research engineer for the chemical firm.

Cinch Buys Printed Circuit Company

CINCH Manufacturing Corp. of Chicago has purchased Graphik-Circuits of Pasadena, Calif., printed circuit producer.

The firm will be operated as a division of Cinch.

Cinch produces printed circuit sockets and terminals, and these can now be furnished installed in the printed circuit boards.

Harry R. Gillespie, Jr., who was administrative engineer for Cinch, is in charge of this operation.

Electrical Facilities Changes Name to Knopp

ELECTRICAL Facilities of Oakland, Calif., manufacturers of precision transformers, testing equipment and rectifiers, has changed its name to Knopp Inc.

The change was made for the purpose of having the product name and the manufacturer's identity similar.

Hermetic Seal Acquires Glass Solder

HERMETIC SEAL Manufacturing Co. of Newark, N. J. has acquired the Glass Solder Engineering Co. of Pasadena, Calif. as their west coast division.

H. J. Wittmeyer, vice-president and general manager of Glass Solder, will continue in that capacity.

Electra Manufacturing Moves To New Plant

FIFTY PERCENT more space is provided in the new plant in Independence, Kansas of Electra Manufacturing Co., manufacturer of deposited carbon resistors.

The plant replaces engineering

making a
MARKED IMPROVEMENT
in COLOR CODING products

Industry's color-coding needs range from simultaneous application of up to six bands on wire lead electrical components to color banding drill chucks in the tool business. Meeting these needs are Markem machines (like the 69A shown), type and ink—which do the job faster, better and at lower cost than tedious hand methods ever could. When size, shape or material of your product, part or package poses a marking problem, get the benefits of Markem's 44 years of experience. Write or call Markem Machine Co., Keene 5, New Hampshire.

MARKEM ...TO MAKE YOUR MARK

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and production facilities which were located at Atchison, Kansas and Kansas City, Missouri.

Feedback Controls Names Vice-President

WILLIAM M. PEASE has joined the staff of Feedback Controls, of Alexandria, Va., as vice-president and general manager. He was formerly the director of the servomechanisms laboratory at M.I.T. and more recently general manager of the electronics division of Ultrasonics.

Rust Industrial Opens New Plant

RUST INDUSTRIAL CO., manufacturers of remote control units for radio station transmitters, has opened a new 11,000 sq ft plant in Manchester, N. H. The firm, established six years ago, can now double its production capacity to meet demand. Provisions have been made for further expansion in the near future.

Hoffman Acquires National Fabricated Products

HOFFMAN Electronics Corp. has purchased all the outstanding shares of National Fabricated Products, Chicago electronic component manufacturer.

National Semiconductor Products, located in Evanston, Ill., is a subsidiary of National.

Maurice E. Paradise, president and founder of National Fabricated Products, will continue in his former capacity under a long-term contract with Hoffman Electronics. The only change presently contemplated in the operation of the company will be the addition of a department of application engineering to develop maximum usage of the semiconductor products.

Gordon Completes Plant Addition

CLAUD S. GORDON CO. of Chicago completed an addition to its plant at Richmond, Ill. According to the

Closely Regulated
D-C Power Source of
Permanent
Stability

C&C

STAVOLT® POWER RECTIFIERS

- Greatly simplified circuit with fast responding magnetic control of highest reliability.
- No warm-up time, no hunting or drifting.
- Lighter weight, more compact, rugged and field proven. Encapsulated components.
- 11 standard models up to 1500 amps. Meets Spec. MIL-E-7894.

Write for interesting information on STAVOLT rectifiers.

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3410 W. 67th Street, Los Angeles 43, California
Specialists in Rectifier Manufacturing for 26 Years

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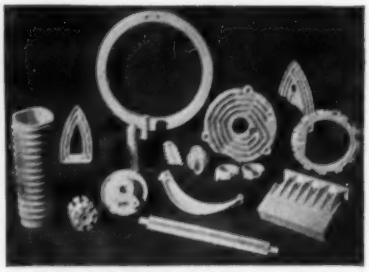

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. . . you can really depend on Star THERMOLAIN® refractory porcelain for exceptional performance in any electrical heating device you manufacture. And for good reason! Star THERMOLAIN offers good mechanical strength plus excellent thermal shock resistance . . . a combination that means long, trouble-free heating-element life and user satisfaction. Want the facts? Standard refractory shapes, plus sizes, weights and engineering data are shown on our new technical data sheet. Write for a free copy today.

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SPADE BOLTS

Specialists in designing and manufacturing of all-purpose fasteners and wire forms. Tooled to produce over 1000 styles in any screw size, material, finish, quantity, to your specifications.

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company, the addition will double manufacturing facilities at the plant where Serv-Rite thermocouple wire, pyrometers, and pyrometer and thermocouple accessories are produced.

Eastern Engineering Established In New Plant

EASTERN ENGINEERING ASSOC. has been established in a new 11,000 sq ft plant in Alexandria, Va. for designing, engineering and manufacturing printed electronic wiring and circuits. Facilities for research development and manufacturing of diversified electronic equipment are included.

Chem-Etched Circuits Firm Organized

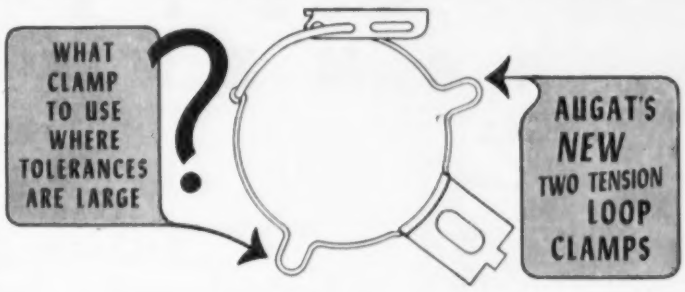
CHEM-ETCHED CIRCUITS, of Garrett, Ind. has been formed to design, develop and manufacture etched circuits by the photo-engraving method. George C. Weiss is president of the newly formed organization. Other officers include Kenneth L. Grimes, vice-president; Bernard H. Barnett, secretary-treasurer; Kenneth L. Smith, sales manager and James E. Wolfkiel, Sr., manager of research and development. Production is already under way on specially designed equipment automatically producing multiple-unit sheets.

Lenkurt Builds New Canadian Plant

CONSTRUCTION of a new $200,000 factory and office building in Burnaby near Vancouver, British Columbia, has been planned by the Lenkurt Electric Co. of Canada, subsidiary of Lenkurt Electric in San Carlos, Calif.

Construction began in June and should be completed in time for all operations to move there early in 1956 from the present plant in Vancouver.

The new building will have a total of 15,000 sq ft of space, more than twice as much space as the present



Augat two-tension loop clamps are the long-sought answer for uses where tube base tolerances vary up to .040. The bands of these sturdy clamps are made of Beryllium copper, heat treated to retain original tension and nickel plated to withstand a 96 hour salt spray test with no adverse effect.

The remaining parts of Augat's two-tension loop clamps are made of 18% nickel silver.

Write today for catalog and samples.

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When you need a
Non-Stock Pot
ask
HELCO
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Manufacturers of
Ultra High Precision Potentiometers
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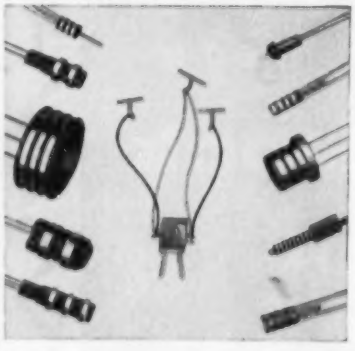
SINGLE STRAND
STRANDED CABLE

from .0005" *to* .250"

New automatic machinery increases production, assures higher uniform quality *at considerably lower costs!* If you use filaments or stranded cable, ask for samples and quotations.

MICRO-*Wire* STRANDING COMPANY
131 Park Place — Passaic 1, N. J.



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SLIP RING ASSEMBLIES
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COMMUTATORS

and other
Electro-Mechanical Components

PRECISION MADE TO YOUR OWN SPECIFICATIONS

Precision molded products with exacting tolerances in precious and non-precious solid metals of all alloys. All types of Thermo-Plastic and Thermo-Setting materials.

Slip Ring Assemblies fabricated or one-piece precision molded to your specifications in Nylon, Kel-F, Mineral filled Mellamine, Phenolic, and other materials. Rings and leads spot welded or brazed together for positive electrical circuit.

Our Swiss methods and techniques are geared to meet exacting requirements. We invite your inquiries.

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factory. Two thirds of the space will be for production, the rest for offices.

Lear Promotes Two Officers

ANDREW F. HAIDUCK, formerly vice-president, was elected executive vice-president in charge of manufacturing of Lear. Chester D. Seftenberg, formerly treasurer, was elected vice-president and treasurer. All other officers of the firm were reelected.

Masco Elects New Officers

THE MARK SIMPSON Manufacturing Co., (Masco) appointed the following new officers:

Miryam Simpson, president; Mark Simpson, vice-president & secretary; Bernard Zisman, vice-president & treasurer; George Watson, vice-president, distributer sales division; Philip S. Optner, vice-president, mfg. division and Ralph Aasen, vice-president of engineering.

Ports Selected As Vice-President

DELMER C. PORTS, chief engineer of Jansky & Bailey, has been elected vice-president of the firm.

Ports is chairman of the IRE Professional Group on Antennas and Propagation. He has been with the company since 1936.

Leach Changes Executives, Sells Jeffries

C. R. HARMON has resigned as president of Leach Corp. K. F. Julin, executive vice-president, has been appointed to act as general manager, and Harmon, who has been instrumental in the initial stages of the company's successful operation, will continue in a consulting and advisory capacity.

Jeffries Transformer, formerly a member of the Leach family, was

Lean on us for HEAT TREATING SERVICES

Ultramodern facilities and equipment*, fast service, unmatched experience, and rigid adherence to specifications make it your best move to lean on us for these services.

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EXPORT ORDERS FILLED PROMPTLY
CABLE ADDRESS: ALRAD-PHILA.

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sold recently to Zinsco Electrical Products.

Leach plans further acquisitions of compatible companies in the future.

Underwood Corporation Changes Officers

L. C. Stowell

L. C. STOWELL was elected as chairman of the board and Fred M. Farwell as president of Underwood Corp.

Phillip D. Wagoner, who has been president and then chairman of the board since 1918 continues as a director, a member of the finance committee and chairman of the executive committee.

After 17 years with Dictaphone Corp. where he became president in 1927, L. C. Stowell joined Underwood as executive vice-president in 1936, becoming president in 1945.

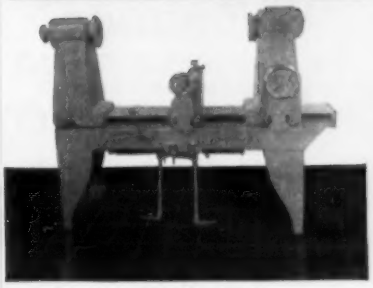
Farwell was executive vice-president and a director of S. C. Johnson & Son, of Racine, Wisconsin.

Long Island Plant Bought By Superior

SUPERIOR TUBE CO., has acquired a majority interest in Johnson & Hoffman Manufacturing Corp. of Mineola, Long Island, New York, manufacturers of precision stamping and deep-drawn parts, primarily for the electronics industry.

Jay H. Johnson, president, and Eugene J. Hoffman, vice-president,

GLASS WORKING LATHES



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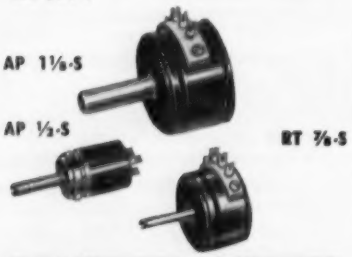

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will continue in direct charge of Johnson & Hoffman's operations.

Consolidated Engineering Appoints Computer Chief

GLYN A. NEFF has been appointed project chief for data processing systems of the systems division of Consolidated Engineering Corp.

In his new post, he will be concerned primarily with data processing systems as they are used in design and testing of atomic reactors, jet engines and guided missiles.

Neff was transferred from the company's engineering division, where he played a role in development of MilliSADIC, a high-speed electronic data processing unit that converts electrical measurements of physical phenomena into numerical form.

Prior to joining the company four years ago, he was engaged in airborne receiver development as an engineer with Collins Radio Co.

Insulated Circuits Moves To New Plant

INSULATED CIRCUITS has broken ground for a new plant in West Caldwell, N. J. The plant has been designed for automatic production. Each phase of circuit, switch or assembly will be manufactured under dust free, humidified and temperature controlled conditions. The new plant will contain approximately 32,000 sq ft of working area. Facilities for prototype, research and development will be segregated

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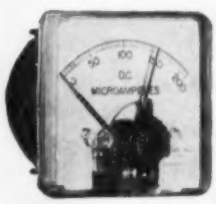

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Suggested circuits for meter-relays and complete specifications including prices are covered in new 16-page Bulletin G-6, which you can get by writing Assembly Products, Inc., Chesterland 4 Ohio.

Booth A-150, Instrument Show, Sept. 12-16, Los Angeles
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from regular production. The move from the present location at Belleville, N. J. to the new location has been planned to cause a minimum loss of production time.

Audio & Video Elects Two

R. E. HADADY has been elected to vice-president of Audio & Video Products in charge of field engineering. James U. Lemke was elected vice-president and chief engineer for A-V Manufacturing Corp., a division of Audio & Video. Hadady will direct national sales and field engineering activities. Before joining A-V, he was manager of the customer engineering division of Davies Laboratories.

Lemke will supervise all research and development operations of A-V Manufacturing.

Gaunt Joins Lockheed Research

RICHARD P. GAUNT has joined the Lockheed missile systems division as a member of the research staff. He has been associated with the CalTech Jet Propulsion Laboratory as senior research engineer in charge of a missile systems group.

He has designed special-purpose analog computers and differential analyzers.

Polarad Forms Auto Specialty Division

POLARD ELECTRONICS CORP. has formed a new division to manufacture and merchandise automotive and bicycle specialties.

The move is the first step in a diversification program to utilize to the fullest the firm's engineering and production facilities.

Louis Stark, from the automotive specialties field, has joined Polarad to act as general manager of the new division.

Consolidated Diesel Establishes Subsidiary

CONSOLIDATED Diesel Electric Corp. has formed a subsidiary, Consolidated Avionics Corp. Harry R.

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Constant Voltage	Continuously Variable (a) Output No. 1, pos. or neg. 0-1V, 0-10V, 0-100V*
	(b) Output No. 2, pos. or neg. 0-190V
Ripple	0.01%
Line Regulation	Less than ±1.0% change for input 95 to 125 VAC
DC Current (max.)	Either output, 100 MA max.
Constant Current	Adjustable, 2 to 30 MA
Current Regulation	Constant within ±1.0% for output 0 to 150V
Ripple	Less than 0.05%
Line Regulation	Less than ±2.0% change for input 105 to 125 VAC
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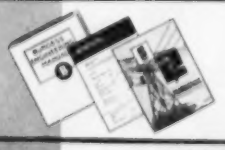

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Glixon, formerly of the Servo Corporation of America has been appointed president. The subsidiary will engage in the manufacture and development of servos, digital data reduction and electronic instrumentation. Glixon holds a research fellowship at New York University.

Bristol Engineering Promotes Snyder

MERLE E. SNYDER has been appointed manager of the electronics division of Bristol Engineering Corp.

Snyder joined Bristol in 1950 and assisted in forming what is now the electronics division. He was previously associated with Kellogg Switchboard and Supply.

National Research Names Minault

S. SYDNEY MINAULT has been appointed general manager of the equipment division of National Research Corp. in Cambridge, Mass.

He has previously served as production manager and later vice-president and general manager of Tracerlab; chief product engineer, camera plant manager and later chief engineer of Ansco; methods supervisor and later manufacturing engineering superintendent of Sperry Gyroscope.

Eimac Elevates Howes, Culbertson

GORDON HOWES has been appointed administrative assistant to the general manager of Eitel-McCullough, manufacturer of Eimac electron-power tubes.

Robert Culbertson will succeed Howes as director of factory engineering.

Howes began his career with the company in 1935, only a few months after the firm was founded. In 1941, he laid out plans for the firm's Salt Lake City, Utah, plant and remained there as plant manager until 1943. On his return to San Bruno, he organized the factory engineering department and remained its di-

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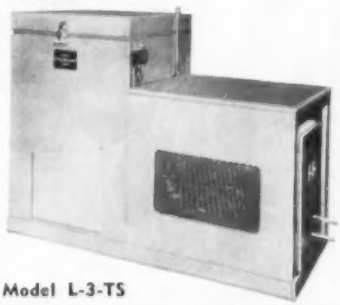

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Gordon Howes

Robert Culbertson

rector until his recent promotion.

Culbertson joined the Eimac staff in 1952 as a laboratory chemist. He was appointed chief factory chemist and for the past year has served as assistant to the director of factory engineering, in charge of factory chemistry.

IRC Acquires EMEC

INTERNATIONAL Resistance Company, through one of its California subsidiaries, has purchased EMEC, of Seattle, Washington. EMEC manufactures magnetic clutches for electronic and electrical applications.

Miller Buys Vidaire Stock

GEORGE MILLER, president of Vidaire Electronics of Lynbrook, N. Y., has purchased all outstanding shares in the corporation. Joseph DeRosa is no longer connected with company.

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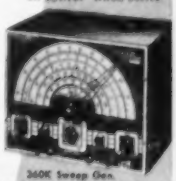

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New Books

Transistors: Theory and Applications

BY A. COBLENZ AND H. L. OWENS. *McGraw-Hill Book Co., New York*, 1955, 313 *p*, $6.00.

THE AUTHORS of this book have struck the mark on which they took aim. The result is a bull's-eye in presenting the basic facts about transistors to the intelligent novice. The book is of great help to the electronic technician engaged in transistor work and serves as a valuable tool to the engineer who is first entering this fascinating field. The engineer working in the field of transistors should have this book on his reference shelf to help him keep his two feet on the ground.

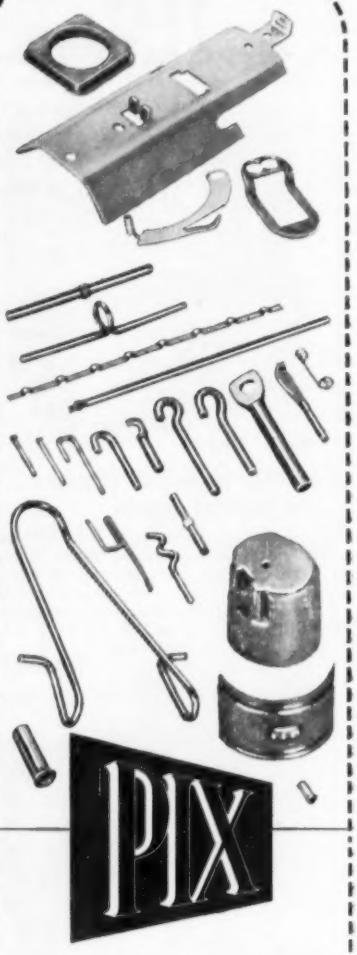
This book is based on a series of lectures given by the authors at Evans Signal Laboratory and Coles Signal Laboratory while they were members of the Signal Corps Engineering Laboratories Staff. The lectures were expanded into a series of articles appearing in ELECTRONICS magazine from March, 1953 until January, 1954. The book adds many other useful chapters.

Format

The book is divided into five general sections: the physics of transistors, the nature of transistor phenomena, the characteristics of the transistor in circuits, the manufacture of transistors and special topics.

Chapters 1 through 5 discuss the basic physical facts of solid state physics in such a manner that energy gaps and potential barriers are readily understood on the basis of electron theory and quantum theory. Both these subjects are adequately discussed to provide the foundation for the theory of transistors.

Chapters 6 through 9 inclusive discuss the theory of operation of point-contact transistors, junction transistors, tetrode transistors, *p-n* hook transistors and phototransistors. The authors cover the various characteristics of the various transistors and how the manufacture results in variations of these characteristics. Typical values are given for the various types and



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comparisons are made. In these chapters the equivalent circuit is developed and input resistance, output resistance and other characteristics derived. Characteristics as power gain, voltage gain and small signal parameters are covered in these chapters.

Transistor Circuits

Chapters 10 through 12 inclusive, treat the transistor in the circuit. Amplifiers of the grounded emitter, grounded collector and grounded base types are examined, characteristics compared and advantages stated. A handy chart is included covering the characteristics of the three basic amplifiers. A special chapter is devoted to switching applications. The cascading of various types of amplifiers and their coupling problems is further discussed in another chapter.

The manufacture of germanium and silicon transistors is fully covered in chapters 13 and 14. Types of sampling tests are covered in these chapters which also contain a comparison of silicon and germanium.

In chapter 15 the authors review suggestions as to new types of transistors such as the analog transistor, unipolar field-effect transistors, fieldistors and others. Appendix I lists the four-pole parameter transformation equations. Appendix II gives the generalized equations for transistors in cascade. Appendix III is extremely worth while. In it are contained sections of MIL-T-12679A which cover the standard definitions of the various characteristics.

All factors being considered this is a book worth having in a personal library. An excellent bibliography is given at the end of each chapter.—R. S. SHERRY, *The W. L. Maxson Corporation, New York, N. Y.*

Principles and Practice of Electrical Engineering

BY G. A. WALLACE. *McGraw-Hill Book Co., New York*, 1955, 598 *p*, $7.50.

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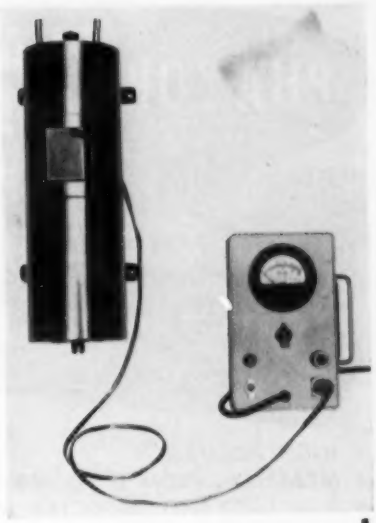

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this book reviews basic electrical physics, explains the generation, transmission and use of electrical power and treats the operating principles of generators, motors, transformers, transmission lines, meters, illumination and electronic devices.

Electronic Devices

Chapter 41 deals with the operation of thermionic tubes and photoelectric cells. The chapter starts out by describing the operation of the thermionic triode and introduces the student to static characteristic curves, tube factors and dynamic characteristics. Circuits are given for R-C and transformer-coupled amplifiers, the push-pull output stage, stabilized amplifiers and oscillators. Also treated are tetrodes, pentodes and thyratrons.

The book concludes with sections dealing with phototubes and other light-sensitive cells, a description of the cathode-ray oscilloscope and a basic electronic timing circuit.—J. M. C.

Modern Physics for the Engineer

EDITED BY L. N. RIDENOUR. *McGraw-Hill Book Co., New York*, 1954, 499 *p*, $7.50.

AS SOON as a man calls himself a "scientist" something happens to him. He seems to become cloistered in exalted realms and be much too good for the average of his fellows. In particular, he achieves a compulsion to look down his nose at the lowly engineer. It is in this happy spirit that Dr. Weller writes the introduction to this book. It would be difficult indeed to achieve an introduction more calculated to make even a research engineer sigh: "The damn physicists again" and toss the book in a corner.

Scope of the Book

But he would be very wrong to do so. For here in one volume is a group of lucid, comprehensive articles on many of the fields of modern physics. Even a hasty survey of them cannot fail to add breadth to an engineer's viewpoint. Starting with Relativity and the Foundations of Mechanics, there are articles on Atomic Structure,

Physics of the Solid State, Magnetism, Microwave Spectroscopy, Nuclear Structure and Transmutation, Electronuclear Machines, the Actinide Elements and Nuclear Power, Elementary Particles, Astrophysics, High Pressure Phenomena with Applications to Geophysics, The Earth Beneath the Sea, Thunderstorms and Lightning Strokes, Transient Phenomena in Supersonic Flow, Electrons and Waves, Semiconductor Electronics, Communication Theory and the Transmunication of Information, and Computing Machines and the Processing of Information.

Quite a list. And most of the articles are written to and for the intelligent engineer. In general they start with a qualitative description of the problem and how it has been tackled, proceeding into the quantitative analysis with what mathematics may be necessary, and ending with a statement of the present day position. These are articles from which the busy engineer can extract just as much as he needs and has time for. In some cases a hasty skimming will suffice, for background information only, while in other articles a careful understanding will be found desirable. Each individual can fit the pattern to his own desires.

It is difficult to choose the better articles but the chapters which appealed most to this reviewer were those on Atomic Structure, Physics of the Solid State, and High Pressure Phenomena. Doubtless others will have other preferences.

What's Missing

It would be quite interesting to know how the list of subjects was chosen. There is nothing on such varied topics as Low Temperature Phenomena, Optics, Sound, Thermodynamics and Electromagnetic Propagation, to mention a few. Can it be that no interesting work is going on in those fields?

Furthermore, in a book on Modern Physics these topics would seem to be much more congruous than dissertations on the applications of vacuum tubes and digital computing machines. To me Communication Theory would seem to belong to the mathematician and Computing Machines and the Processing of Information to the engineer. It does not seem accidental that the ancestors of the present computing machines, both analog and digital, were nurtured in engineering schools and by engineers. Nor does it seem odd that order was brought into information theory by mathematicians. If the physicists find use for them that is fine, but it does not seem to make them a part of modern physics.

To show how dangerous this inclusion is, the author is trapped into discussions of "diddling" the information fed into the Univac on election night, the alarm of the mushroom growers on the disappearance of the horse and other gems of social (?) significance.

If you scrape the two crusts off this pie, you will find the filling juicy and palatable. — KNOX MCILWAIN, *Hazeltine Electronics Corp., Little Neck, L. I.*

The Theory and Practice of Telegraphic Transmission

BY R. ROQUET. *Editions Eyrolles, Paris, France,* 1954, 252 *p,* 2,750 *francs.*

THE FULL TITLE of this book, published in the French language, is "Théorie et Technique de la Transmission Télégraphique; Tome 1: Théorie, Avec Extension a la Transmission de l'Information."

The growing importance, in modern telecommunication, of pulse techniques and information theory has developed in many countries a lively interest in the transmission of unit signals. One had hoped that a definitive work on "The Pulse" would sometime emerge from the country whose administration of posts and telegraphs, in the tradition of Baudot, had had the subject under scrutiny for more years than had any other. This book is it.

Written by the chief engineer of the French Post Office telecommunication academic extension department, and particularly slanted to the use of students preparing themselves for examinations leading to professional advancement, this work brings together the elements necessary for serious study

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of the propagation of wavefronts on wires. It is one of the virtues of the European system of qualifying for advanced engineering status that tutorial compilations of this type are made available for widespread use, in contrast to the American system under which only the most ambitious students do their own digging in Malcomb, Milnor, Carson and Gilbert.

The adequate, mathematically basic exposition under review, clarified by 178 graphs and diagrams, is grounded in telegraphy and does not stray far from its precincts. While there is a studied attempt at generalization made throughout, and while portions of several chapters are devoted to communication systems responsive to multiple-level, quantized power increments, the work as a whole is tied to on-off, two-current or three-current wire transmission. In that field, it is impeccably thorough.

Carrier-current a-c modulation theory is well expounded, but one looks almost in vain for references to television, radar, computer and telemetering applications of the pulse; these, presumably, are reserved for a tome or tomes to come. Despite Volume One's subtitle: "Avec Extension a la Transmission de l'Information," Roquet is no Gallic counterfoil to Shannon and Wiener.

The Contents

The book is divided into three parts. The first defines transmission terms employed in telecommunication, and addresses itself to signals as conveyors of information, their propagation and their distortion in transmission. The author, whose high position in the European telegraphic consulting committee's standardization work is reflected in his meticulous definitions, has produced a superior pedagogical product in these initial chapters that might well be emulated in the United States.

In the second part, the author considers modulation: the production of electrical phenomena at the point of departure, transient phenomena on the line and demodulation at point of arrival. In the third part, selected concrete problems are introduced as a means of

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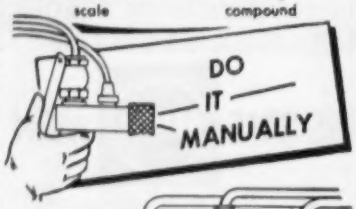

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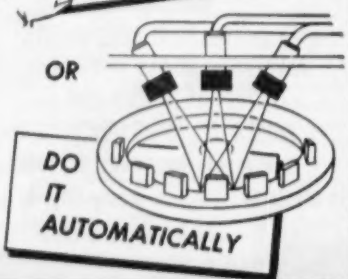

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indicating how theory may be extended to meet them.

Most of the information in this book is available to transmission engineers in the American and British technical press, but not in so convenient a compilation. The book should be useful to bilingual Canadians and to U. S. French-reading authors, teachers and graduate students; to librarians; to engineers active in communication standards work and to the growing number of American industrial and government technicians who participate in the C. C. I. activities of the International Telecommunications Union.

The only anachronistic feature of this paper-covered, offset-printed book, in approximately 8½" by 11" format, is its price, which, by some esoteric relationship of the corrugated franc and the neoprene dollar, translates into $7.86.—I. S. COGGESHALL, *Western Union Telegraph Co., New York, N. Y.*

Thumbnail Reviews

Contract Termination Guide. Manufacture Department, Chamber of Commerce of the U. S., 1615 H St. NW, Washington 6, D. C., 60 p, 1954, $1.00. A guide through the confusion and inconsistencies of government contract termination settlement.

Standards on Electrical Insulating Materials. ASTM, Philadelphia, Pa, 1955, 660 p, $5.50 (paper). Updates specifications published in 1953 and includes revisions up to Feb. 3, 1955. Includes 60 testing methods, 17 specifications.

Numerical Methods. By Andrew D. Booth. Academic Press Inc., 1955, 195 p, $6.00. Expounds basic principles of numerical analysis from the point of view of readers interested in learning how to program automatic computers.

Wireless and Electrical Trader Year Book: Radio, Television and Electrical Appliances 1955. Trader Publishing Co. Ltd., London, England, 1955, 304 p, 12/6. Information on British radio-tv sets, receiving and c-r tubes and the radio-tv servicing business. Of interest to overseas buyers wishing to contact British sources of supply.

Basic Electronics. By Van Valkenburgh, Nooger and Neville, Inc. John F. Rider Publisher, Inc., New York, 1955, 560 p (five volumes, paper), $9.00. Home study course without correspondence question and answer service. Covers components, basic circuits, receivers, transmitters and antenna systems. Very elementary.

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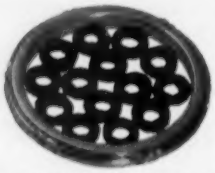

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Backtalk

Those Early Days

DEAR SIRS:

FRANK ALEXANDER'S "About Whistlers" (*Backtalk*, p 380, Aug. ELECTRONICS), also rings a loud bell in the far recesses of my memory.

In 1918, while researching on r-f detection phenomena for E. J. Simon, Inc., radio contractors, in New York City, I was working with a Marconi magnetic detector, used by the British Marconi Wireless Telegraph Co. for some years prior to 1910 for spark signal detection, but hardly even known of by present day radio engineers.

In it an endless, round belt of insulated fine, soft, iron wires moved slowly through a glass tube carrying a layer of copper wire, and through which the r-f signal current passed. Around this a narrow, many turn secondary coil spool was located at its mid point.

Two U-shaped permanent magnets, with like poles adjacent and at the middle of the coils, sprayed a magnetic field along the iron wire belt, moved by a clock work drive at a speed of about 4 inches per second. The secondary coil was normally connected to a head phone. The r-f currents in the small inner coil annul the hysteresis of the iron and create an induced a-f current in the secondary winding and telephone.

With this magnetic detector I used a three-stage audio amplifier between the secondary and the head phones.

When the band was in motion, a strong and steady hissing noise was heard in the phones which, I deduced, was set up by the 180 degree turning of the molecular magnets in the iron as they passed through the reversed magnetic field at the coil center. I thought this very interesting and demonstrated it to a number of my associates, among whom were, E. J. Simon, Oscar Roos, Ben Liebowitz, Frank Hinners, Joe Freed, Larry Lesh, and possibly Lester Jones if he was there that early.

While nothing ever came of these experiments, the concept of molecular magnets in the soft iron, twisting end-wise on their axes to pro-

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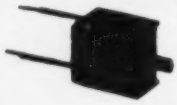

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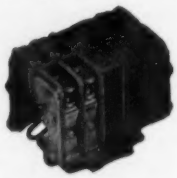

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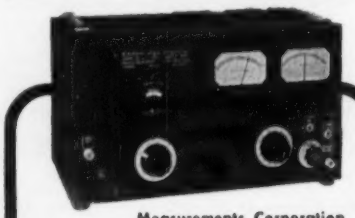

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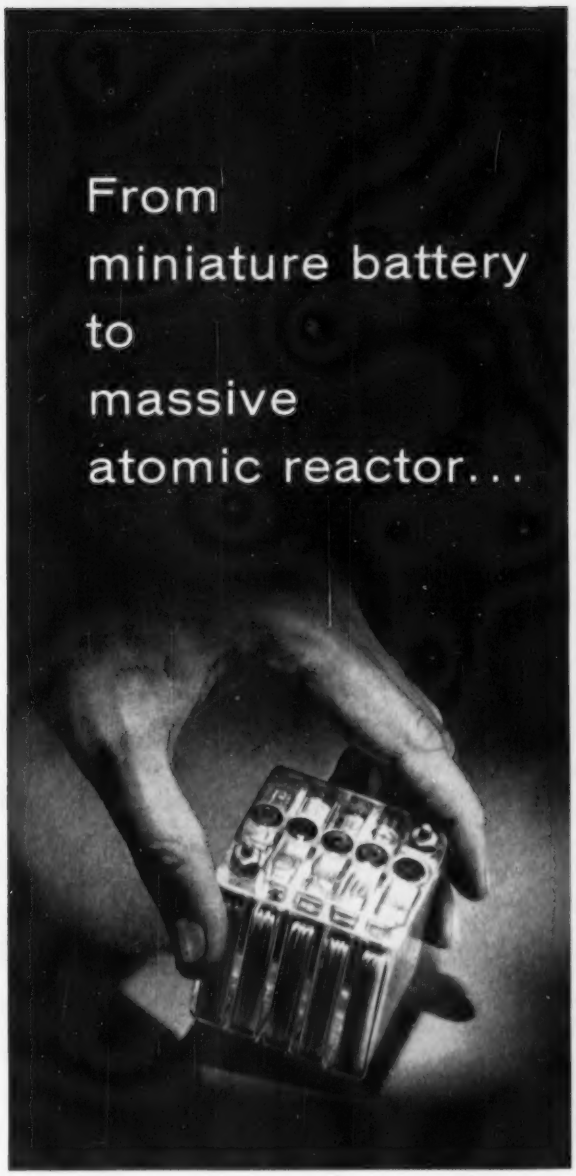

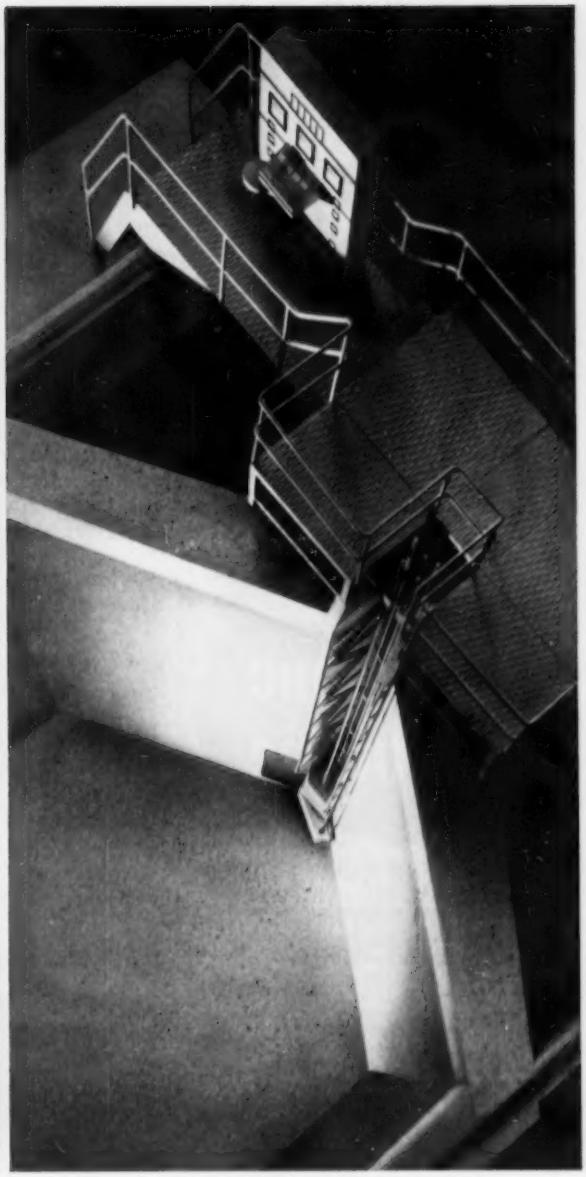

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duce the hissing noise, has stuck strongly in my memory.

During this same investigation, I plotted (and still have) characteristic voltage-current curves of many kinds of electrolytic and contact detectors. These curves look surprisingly like those of our modern transistors and I believe that the electrolytic types might well deserve further scrutiny in this light, especially with an insulated grid electrode for controlling the current flow. I might also add that my first patent #1,104,065 of July 21, 1914, and filed Oct. 5, 1910 covers broadly the original "cat whisker" detector, so much used in the earliest days of radio broadcasting, and so suggestive of modern transistors.

B. F. MIESSNER
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EDITOR'S NOTE: Recent letters in *Backtalk* have related a number of anecdotes of the early days of the art and industry (perhaps more art then and industry now).

Although the name of this department was coined to cover letters back from readers it seems most appropriate to cover also subjects away back in history.

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Radar technicians of Royal Canadian Air Force who have manned the northern radar fence installations are here shown taking further instructions from General Electric engineers on use of the new MPS-14 mobile height-finder radar that can detect planes three times as far as previous units. The equipment was developed in collaboration with Rome Air Development Center

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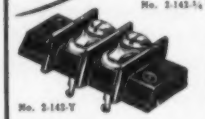

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THE MAN WE MEAN IS A COMPOSITE of the editorial staff of this magazine. For, obviously, no one individual could ever accomplish such a vast business news job. It's the result of many qualified men of diversified and specialized talents.

AND, THERE'S ANOTHER SIDE TO THIS "COMPOSITE MAN," another complete news service which complements the editorial section of this magazine — the advertising pages. It's been said that in a business publication the editorial pages tell "how they do it"—"they" being all the industry's front line of innovators and improvers — and the advertising pages tell "with what." Each issue unfolds an industrial exposition before you—giving a ready panorama of up-to-date tools, materials, equipment.

SUCH A "MAN" IS ON YOUR PAYROLL. Be sure to "listen" regularly and carefully to the practical business information he gathers.

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McGRAW-HILL PUBLICATIONS

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As a service to readers, ELECTRONICS presents the advertisements for some of the leading manufacturer's representatives in the electronics industry. These firms are qualified to help the Manufacturer with his distribution problems; the Buyer with his product needs.

CONTACTS

FOR THE FIELD OF ELECTRONICS

S. BOSWORTH & CO.
Engineering Sales Representatives
PRECISION ELECTRONIC INSTRUMENTATION
COMPUTERS—CONTROLS
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In Metropolitan New York and Adjoining Areas
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Other Offices: Pittsburgh, Baltimore, Washington, D.C.

One inexpensive modern device . . .

can frequently help speed up operation and maintenance or production.

One product advertised in the "Contacts" Section may be the answer to your problem . . . a real money-saver.

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Precision
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GOLD and SILVER
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PLeasant 3-6472

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- Merchandise your advertising
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- Pin-point geographical or functional groups
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Direct Mail is a necessary supplement to a well rounded Business Paper advertising program.

Most progressive companies allocate a portion of their ad budgets to this second medium at the same time as they concentrate on the *best* business publications.

600,000 of the top buying influences in the fields covered by the McGraw-Hill publications make up our 150 mailing lists. Pick YOUR prospects out of our Industrial Direct Mail catalogue.

Write for your free copy of our Industrial Direct Mail catalogue. With complete information.

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SHORTED TURN
INDICATOR
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- VOICE ACTIVATED "SELF-START STOP"

Permanent, unalterable, indexed recording at only 3c per hr. Records in closed briefcase with hidden mike —conferences, lectures, dictation, 2-way phone—while walking, riding, flying.

MILES REPRODUCER CO., INC.
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EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Positions Vacant
Positions Wanted
Part Time Work

Civil Service Opportunities
Selling Opportunities Wanted
Selling Opportunities Offered

Employment Agencies
Employment Services
Labor Bureaus

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$2.10 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

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Discount of 10% if full payment is made in advance for 4 consecutive insertions.

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Send NEW ADS to ELECTRONICS, 330 W. 22nd St., N. Y. 36, N. Y., for October issue closing September 1st

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Qualified Electronic and Electro-Mechanical engineers find happy association with a Western electronics pioneer and leader.

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(A SUBSIDIARY OF HOFFMAN RADIO CORP.)

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Please outline briefly your experience or personnel needs to:

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220 S. State St., Chicago 4, Ill.
HArrison 7-8600

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Two unusual openings which provide opportunity to gain varied experience in a small laboratory in which each man contributes to the projects of others, and maintains full responsibility for his own.

Work is in development and design of electronic test equipment over the frequency range of 100 kilocycles to 2000 megacycles. It requires a minimum of 5 years experience in design and development of electronic equipment, with facility in the use of precision test equipment.

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Please send resumes, including salary requirements, to W. C. Moore, Engineering Manager. Convenient interviews will be arranged in New York for qualified applicants.

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Boonton New Jersey

"PHYSICIST"
$6600-7200

Heavy math, little chemistry. Supervise small testing lab. Knowledge of instrumentation necessary. Several other good openings.

Contact BOB POORE

O'SHEA EMPLOYMENT SYSTEM
"America's Largest"
64 E. Jackson, Chicago, Ill. Tel. WAbash 2-1884

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITIONS VACANT

A medium-sized southern New England manufacturers of technical papers used by the electronics industry has a challenging position for an electrical engineer under 35. Some selling or administrative experience is desirable. He must have a strong persuasive personality and be capable of working with both technical and nontechnical people. Salary open. Include resume of personal history, education, and experience with introductory letter to box P-7081, Electronics.

Faculty Position, teaching, research (Solid State Physics) salary, rank, dependent upon qualifications. Graduate Assistantships (Teaching, research, or combination—Solid State Physics) leading toward MS. Out-of-State tuition waived. $1600-1800 for 12 months. Z. V. Harvalik, Physics Dept., University of Arkansas, Fayetteville, Ark.

Assistant Professor of Electrical Engineering. University of North Dakota, Grand Forks, North Dakota. Duties: teaching electronic and communications courses to undergraduate students. An advanced degree plus some teaching or industrial experience preferred. Submit resume of education and experience to Head, Electrical Engineering Dept.

POSITIONS WANTED

Component Parts Engineer specialized in small electronics parts with a practical reliability philosophy for missile environments. Fifteen years experience in aircraft and missile electronics. Desires a responsible position where evaluation and test methods can be of value. PW-7311, Electronics.

Chief Engineer, cathode ray tubes, heavy on design, factory processing, screening and aluminizing. Cost and production conscious. Desire top level position. Willing to do consultant work on a limited time basis. PW-7389, Electronics.

SELLING OPPORTUNITY WANTED

Manufacturers Representative covering Middle Atlantic area, with three years experience as radio engineer and four years experience in sales and administration with large company and one year as manufacturers representative, desires to take on additional lines. RA-7277, Electronics.

★ ***MANUFACTURERS***
Let us handle technical sales representation of your products

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We will share the cost of protecting your invention if accepted for commercialization

We Specialize in Electronics, Nucleonics, Instrumentation, Servomechanisms & Cybernetics.

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Technical Sales Representation & Research & Development Engineering
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REpublic 2-3651

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$12-15,000—NO FEE

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MANUFACTURERS REPRESENTATIVE

Long established highly successful sales organization seeks additional electronic components. Coverage New York State.

RA-6878, Electronics
330 W. 42 St., New York 36, N. Y.

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You, too, can find your future, in one of these fields:

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ELECTRONIC DATA PROCESSING
GUIDED MISSILE ELECTRONICS
AVIATION ELECTRONICS
ELECTRON TUBES

**Plus hundreds of recent engineering graduates, field service engineers, and other categories of engineers.*

FIELDS OF ENGINEERING ACTIVITY	TYPE OF DEGREE AND YEARS OF EXPERIENCE PREFERRED											
	Electrical Engineers			Mechanical Engineers			Physical Science			Chemistry Ceramics Glass Technology Metallurgy		
	1-2	2-3	4+	1-2	2-3	4+	1-2	2-3	4+	1-2	2-3	4+
SYSTEMS *(Integration of theory, equipments, and environment to create and optimize major electronic concepts.)*												
AIRBORNE FIRE CONTROL			W						W			
DIGITAL DATA HANDLING DEVICES			C			C			C			
MISSILE AND RADAR			M			M			M			
INERTIAL NAVIGATION			M			M			M			
COMMUNICATIONS			C I						C I			
DESIGN • DEVELOPMENT												
COLOR TV TUBES—Electron Optics—Instrumental Analysis—Solid States (Phosphors, High Temperature Phenomena, Photo Sensitive Materials and Glass to Metal Sealing)	L	L	L	L	L	L	L	L	L	L	L	L
RECEIVING TUBES—Circuitry—Life Test and Rating—Tube Testing—Thermionic Emission	H	H	H		H	H		H	H		H	H
SEMI-CONDUCTORS—Transistors—Semi-Conductor Devices	H	H	H				H	H	H			
MICROWAVE TUBES—Tube Development and Manufacture (Traveling Wave—Backward Wave)		H	H		H	H		H	H		H	H
GAS, POWER AND PHOTO TUBES—Photo Sensitive Devices—Glass to Metal Sealing	L	L	L	L	L	L	L	L	L	L	L	L
AVIATION ELECTRONICS—Radar—Computers—Servo Mechanisms—Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Design for Automation—Transistorization	C X	C F X	M C F X	C X	C F X	M C F X	C X	C F X	M C F X			
RADAR—Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control	C X	M C F X	M C F X	C X	M C F X	M C F X	C X	M C F X	M C F X			
COMPUTERS—Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms—Programming	C	C F X	M C F X	C	C F	M C F X	C	C F	M C F			
COMMUNICATIONS—Microwave—Aviation—Specialized Military Systems	C	C F	M C F		C F	M C F		C F	M C F			
RADIO SYSTEMS—HF-VHF—Microwave—Propagation Analysis—Telephone, Telegraph Terminal Equipment		I	I F		I	I F		I	I F			
MISSILE GUIDANCE—Systems Planning and Design—Radar—Fire Control—Shock Problems—Servo Mechanisms		M F	M F		M F	M F		M F	M F			
COMPONENTS—Transformers—Coils—TV Deflection Yokes (Color or Monochrome)—Resistors	C	Z C X	Z C X	C	Z C	Z C	C	C	C		Z	Z
MACHINE DESIGN Mech. and Elec.—Automatic or Semi-Automatic Machines		L	L		L	L		L	L			

Location Code: C—Camden, N.J. F—Florida H—Harrison, N.J. I—International Div. L—Lancaster, Pa. M—Moorestown, N.J. W—Waltham, Mass. X—Los Angeles, Calif. Z—Findlay, Ohio

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Mr. John R. Weld, Employment Manager
Dept. A-15J, Radio Corporation of America
30 Rockefeller Plaza, New York 20, N. Y.

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OPPORTUNITIES that offer stability and an assured future. You will work with the most modern electronic equipment and a staff of engineers who are leaders in the field.

To qualify, you must have had previous experience in design and development of communications equipment. Men selected will be given intermediate or advanced level assignments in either a TV, radio or government equipment lab. Positions available for engineers with the following backgrounds:

★ **TEST EQUIPMENT**

Design of electronic test equipment and associated circuits for TV receivers and government electronic equipment.

★ **UHF COMMUNICATIONS**

Applied development and design of military communications apparatus for both transmitters and receivers.

★ **RADAR INDICATOR SYSTEMS**

Development and design to include fire control equipment in the microwave region.

★ **TELEVISION SYSTEMS AND COMPONENTS**

HV Transformers, coils, amplifiers, deflection yokes and tuners as applied to color and monochrome TV

★ **RESEARCH AND DEVELOPMENT**

Engineers with ability to apply fundamental principles of engineering to solving original problems of more than average technical difficulty related to communications projects.

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Please forward complete resume to Mr. W. A. Wecker, Personnel Division

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ENGINEERS

ELECTRONIC and MECHANICAL

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Those graduate engineers who qualify for current openings will find excellent opportunities for professional development through association with the outstanding engineers and scientists concentrating on research, development and design in all branches of the electronics industry.

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Current openings include:

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ENGINEERING SUPERVISORS
MECHANICAL ENGINEERS

VHF and UHF Head-End Design
Audio and High-Fidelity Products
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Deflection Component Design
Deflection Systems
Color Television
Transistor Circuits
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MR. JAMES STARK

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Electronics Park, Syracuse, N. Y.

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We offer the highest starting salary possible considering your qualifications for the job. Experience need not be in computers.

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Remington Rand
DIVISION OF **SPERRY RAND** CORPORATION

ENGINEERING RESEARCH ASSOCIATES DIVISION
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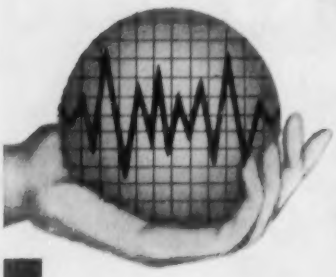
ENGINEERS



How Realistic Are You About Your Future In Electronics?

As the electronics industry grows from $9 billion to $20 billion in the next 10 years, will you be growing with it?

In answering, consider the extent to which your personal progress is dependent on the progress of the company you are with...and the following facts about Sylvania:

- **Sylvania has expanded to 45 plants and 16 laboratories in 11 states**
- **In 6 years, the electronics industry grew 24%; Sylvania grew 32%**
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Sylvania's success story is the story of its creative engineers. These men of talent are given wide latitude to experiment...every facility to test original designs...and are rapidly advanced in the company as is shown by the fact that the average age of high level officials at Sylvania is only 45.

If you are realistic about your future, look into the opportunity now open to join Sylvania...and be high in your profession 10 years from now.

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Majors in E.E., M.E., Math, Physics. Research & Development experience in—

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- Transistor Applications
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- Miniaturization
- Digital Computer Circuits & Systems
- Circuit Design
- Shock & Vibration
- Technical Writing
- Missile Analysis

Missile Systems Laboratory

- Radar Research & Development
- Missile Guidance & Ground Equipment Analysis
- Systems Evaluation Operations Research

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Majors in E.E., M.E., or Physics. Experience in Product Design and Advanced Development in—

- Circuit Design
- Systems Development
- Pulse Techniques
- F.M. Techniques
- Equipment Specifications
- Components
- Microwave Applications
- Servo Mechanisms
- Subminiaturization
- Mechanical Design
- Shock & Vibration
- Heat Transfer

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SYLVANIA ELECTRIC PRODUCTS INC.

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DIGITAL COMPUTER • LOGICAL DESIGN • INFRARED • ACOUSTICS • DIGITAL COMPUTER PROGRAMMING ELECTROMAGNETIC THEORY • COMMUNICATIONS CIRCUIT DESIGN • COMPONENT DEVELOPMENT • RADAR • OPTICS ENGINEERING • SYSTEMS DESIGN

Salary commensurate with training and experience. Excellent working conditions. Liberal vacation policy along with other fringe benefits. Unusual opportunity to carry on University graduate studies while working full time. Moving expenses paid. U. S. Citizenship required.

Write, giving details of education and experience, to

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No frustrations at National

Mr. Hawkins started with National in 1940 testing equipment and writing instruction books. He advanced to Project Engineer on teletype and facsimile equipment development, then to chief engineer of the Communications Receiver Department, and most recently became Staff Engineer. One reason for his steady and rapid progress is the combination of diversified opportunities and the cooperation of superiors that exists at National. It's a combination, says Mr. Hawkins, that makes an engineer's association with National a pleasant and profitable one.

Opportunities at National Now for . . .

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SENIOR ENGINEERS

SEND YOUR RESUME TODAY TO Mr. John A. Bigelow

National
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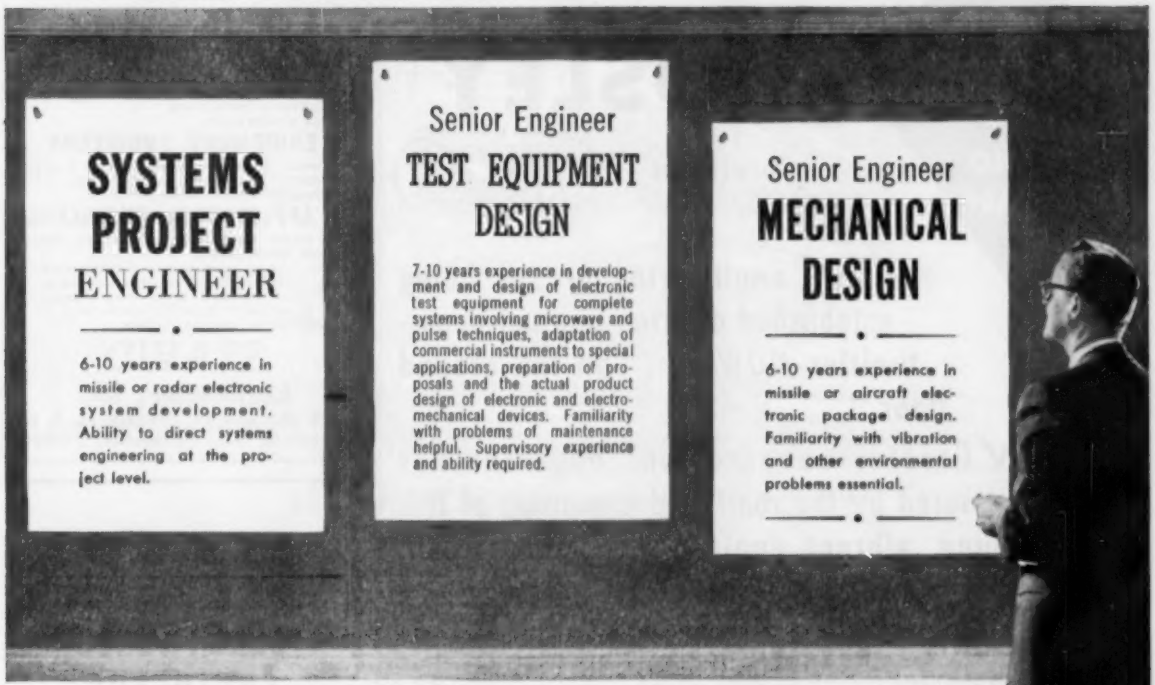
NATIONAL COMPANY, INC.
58 Sherman St. Malden, Mass.

Bendix OFFERS
3 SENIOR ENGINEERING JOBS
WELL WORTH LOOKING INTO...


SYSTEMS PROJECT ENGINEER
6-10 years experience in missile or radar electronic system development. Ability to direct systems engineering at the project level.
Senior Engineer
TEST EQUIPMENT DESIGN
7-10 years experience in development and design of electronic test equipment for complete systems involving microwave and pulse techniques, adaptation of commercial instruments to special applications, preparation of proposals and the actual product design of electronic and electromechanical devices. Familiarity with problems of maintenance helpful. Supervisory experience and ability required.
Senior Engineer
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Here are three especially attractive job opportunities for engineers who want to get on the ground floor in the important, interesting, and challenging phase of a new industry—guided missiles.

Qualified men are given real job responsibilities with Bendix and grow with the development of what is not only the nation's most important weapon system, but a project that will undoubtedly lead to new and important long-range commercial application.

At Bendix you will be associated with top missile authorities and have at your command unexcelled engineering and manufacturing facilities. Salaries for these top jobs and other opportunities are open for discussion. Write today to: Mr. W. L. Webb, General Manager, Missile Section, Bendix Products Division, Bendix Aviation Corporation, 401 North Bendix Drive, South Bend, Ind.

23 OTHER ENGINEERING POSITIONS!

Bendix also offers unusual job opportunities for assistant engineers, junior engineers, and technicians, as well as a score of other assignments. A 30-page book describing in detail every phase of our guided missile operation will be sent to you on request. If you are interested in guided missiles, this book is bound to interest you. Write for it today.

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there are thousands of engineering positions open today...*but*—

HERE'S WHY YOU SHOULD COMPARE

CROSLEY

DIVISION

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✓ New engineering groups being established offering unusual opportunities *NOW* . . . "on the ground floor."

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Electronics and Mechanical Engineers, Physicists and Mathematicians:

- Advanced Research
- Research
- Project
- Advanced Design
- Senior Design
- Design
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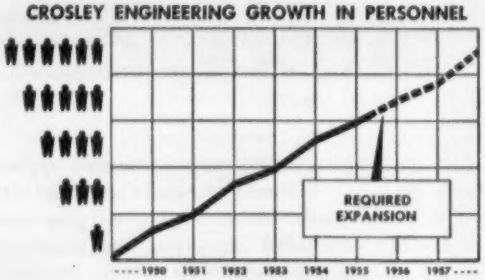

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Excellent salaries, fully equipped modern laboratories, paid vacations and holidays, subsidized university educational program, group insurance program for you and your family, retirement plan and adequate housing in desirable residential areas.

Investigate these opportunities by sending resume to:

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DIRECTOR OF ENGINEERING
Government Products — Crosley Division,
AVCO Manufacturing Corporation
Cincinnati 15, Ohio

ELECTRONIC ENGINEERS

Research & Development
Physicists - Engineers
(SENIORS)

Experienced in research and development of various radar systems including: beacons, missile guidance and counter measures. Advanced training in applied mathematics, noise theory and probability analysis desirable. EE degree or equivalent required.

FIELD ENGINEERS

(SENIORS)
Local & Field Assignments

Must have EE degree, with 3-5 years experience in one of the following:
—Flight Simulators
—Radar & Sonar Trainers
—Fire Control Radar
—Electronic installation and maintenance.

• EQUIPMENT ENGINEERS

3-5 years experience with at least 3 years in circuit packaging. EE degree with mechanical background.

• APPLICATION ENGINEERS

5-10 years experience on coil and transformer development.

Salary and advancement commensurate with ability; liberal vacation, sick leave, 9 paid holidays, group life, sickness and accident insurance plans, and a worthwhile pension system.

STAVID
Engineering, Inc.

U. S. Highway 22, Watchung, P. O.
Plainfield, N. J.—PLainfield 7-1600

WANTED

ELECTRONIC ENGINEERS

Experienced in
Power Supply Design
for Military Applications

One of the country's oldest and largest manufacturers of electronic equipment requires the services of several competent electronic engineers familiar with military specifications and requirements for power supplies. Working environment and surroundings are congenial and stimulating. The company plant is situated in Long Island City.

Our employees are aware of this advertisement. Please furnish written resume and state salary required.

P-7114, Electronics
330 W. 42 St., New York 36, N. Y.

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ELECTRONIC ENGINEERS
ELECTRONIC PHYSICISTS

Bendix Radio has new, exceptional opportunities for advancement while working on:

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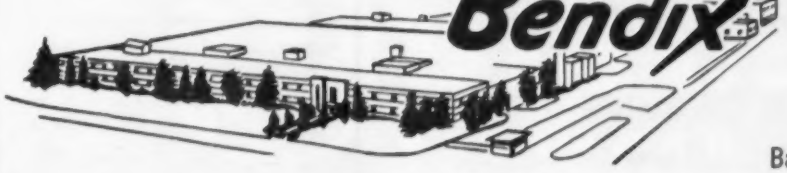

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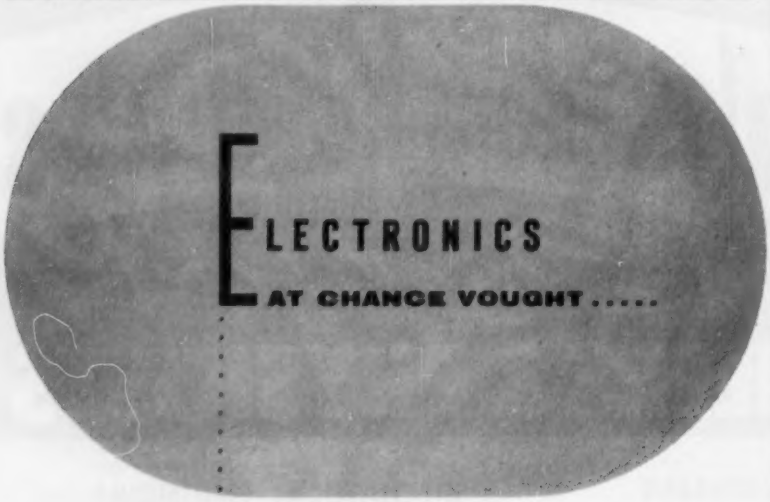

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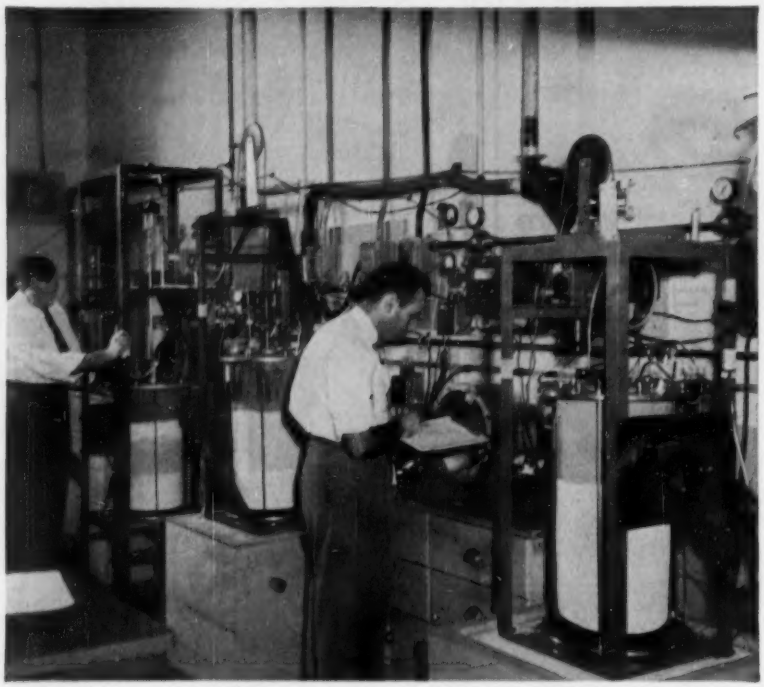

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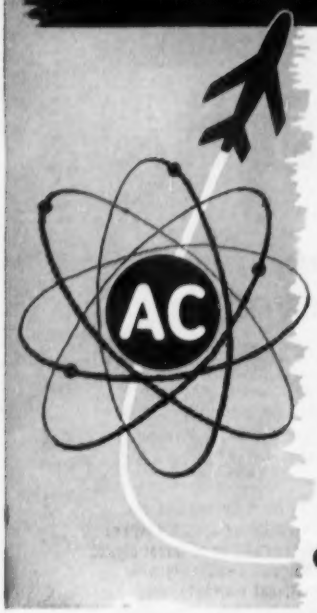

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A DIVISION OF GENERAL DYNAMICS CORPORATION
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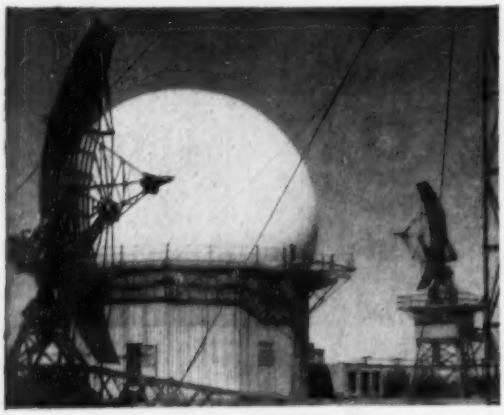

Huge antenna used with new radar height-finder needs a room all its own above the control center in the radome building erected in Arctic climates. Air pressure supports the rubberized glass fabric radome "balloon." Entrance to the radome is through an air lock chamber.

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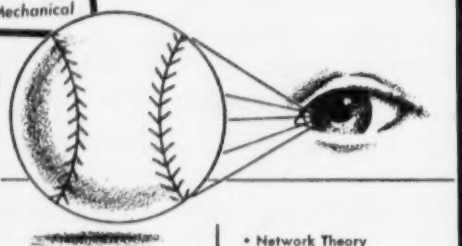

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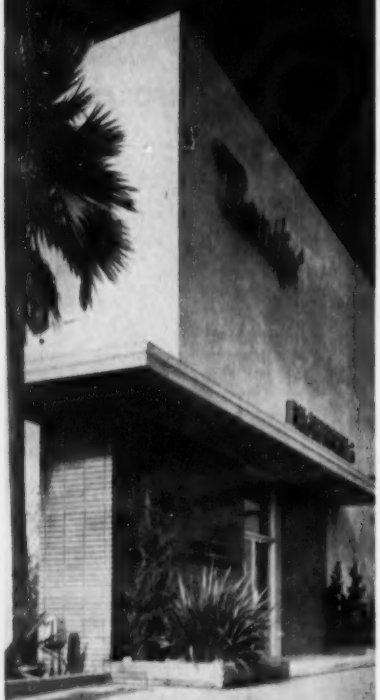

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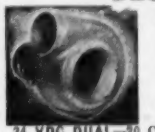

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RESISTORS 2 WATT 5% AB, 24K, 560 ohms, 10¢ Each—Min. Order 100 of Each

CARBON RESISTORS ½ W.....$10 per M. Min. Order 1 W.....20 per M. 100 of 2 W.....30 per M. Each

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CONTROLS—½ & 1meg w/switch.....28¢

CERAMIC CONDENSERS — Tubular. All Sizes $25 per M. Min order 100

90° YOKE UNWIRED.....85¢

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G-5603* Mike-to-Grid. 100-ohm Pri. (with 10 M.A. DC.) to 125,000 W Sec. Response: ± 2db, 250-4000~ ..... 89¢
G-5604* Plate-to-Line 20,000 Ω (with 32 MA. DC) to 600 ohms. Resp. 250/2500 cps, ± 2db, 15 mw. Level $5.4
W-15-21: Hybrid Input Trans #1: 300 w/300 ohm. Trans. #2: 600 ohm/250,000 ohms..... $1.19
W-15-41: Hybrid Output Trans. #1: 300/30 ohm. Trans. #2: 300/13,000 ohm (Plate)..... $1.15
● **SPECIAL:** Set of 2 Transformers: Input Trans. W-15-41 and Output Trans. W-15-21. (Above)..$1.97
KS 9496: Output, 9600 ohms P-P, to 9 ohm V.C. 250 watts, 100~ to 10,000 cps ± 1db..... $8.95
KS 9449: Driver Trans. P-P 6V6 (8000 ohms) to PP Grids Cls. "B" (305's). 10 watts 1000-10,000 cps ± 1db..... $2.45
● **SPECIAL:** Matched Transformers KS 9449 and KS 9496 (Above)..... $9.95
AT 071: Interstage; 10,000 ohm pp plates to 80,000 ug grids. For BC 614 Speech Amplifier..... $1.35
AT 199: Output: 6000 ohm plate to line (200/600 ohms) Response: 200-12 kc. For CF1A and CF 3A.... $2.45
AT 037: Mike to grid: 75 ohms to 125,000 ohms..$.65
J-871: Output: Pri: 20,000/16,000 ohms P-P. Or 5,000 /4,000 ohms. Sec: 500/16/7.5/5/3.75/1.25 ohms, Silicor, hi-fi $2.75
AT SUB Suboncer, Multimatch, 200 ohms to 15 K ohm C.T. and 100 K ohm Grids..... $.69
AT301 HI-FI Special: PRI: 5000 ohms P-P/Sec: 4/16/12/50/200 ohms 60-10,000 CY.—1 db 50W..... $3.49
AT152 HI-FI Driver Pri: 10,000 ohms Sec: 40,000 ohms PP Grids 50-15 KC/1 db..... $1.49
AT602 Output to H. S. or line PRI: 14,200 ohms SEC: 8000/600 ohms $1.10
AT666 Intercon Input: Spkr (4-8 ohms) to grid (250,000 ohms) $0.69
AT415 Plate (18,000 ohms C.T.) to line (125 ohms) 175 w.—500-600 CY..... $1.95
AT858 Plate (10,000 ohms C.T.) to line (125 ohms) (12510 ohms) **HI-FI—50 W**..... $6.95
AT-694 HI-FI Output: 3 Watts, 8500 Ohms P-P to V.C. (15 Ohms) 15-15KC PM 1 db..... $1.49
AT4-1: Mike (35 ohms Carbon) to Line 600 ohm/200 ohm $1.19
AT-448: Line (600 ohms) to V.C. (6 ohms) 17 d.b. Level $1.69
AT-631: Mike-or-Line (200 ohms) To Single or P-P Grids (50K Ohms) $0.59
*Duncer Size

X BAND — 1" x ½" WAVEGUIDE

ROTARY JOINT (APS-6) Sperry PT #658275, 180 deg. rotation, choke-to-choke. Has "Built-in" Di-Coupler. 20 DB., with "N" Takeoff. $22.50
PARABOLOID DISH, 18" diam. Spun Aluminum, 8" Focus. For AN/APS-6 ..... $4.95
3 CM. DIPOLE and Feed Assembly. (May be used with above dish.) 8 inches long $5.00
FLEXIBLE SECTION 9 in. long. Cover-to-Cover $5.50
3CM. DIPOLE FEED, 15" L. for APS-15..... $14.50
MITRED ELBOW, Cast aluminum, 1¼" x ½" W.G. W.E. Flanges, "E" Plane $3.50
3 CM ANTENNA ASSEMBLY: Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern: 5 deg. in both Azimuth and elevation. Sector Scan: over 160 deg. at 35 scans per minute. Elevation Scan: over 2 deg. Tilt: Over 24 deg. $35.00
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Pressure Gauge Section with 15 lb. gauge..... $10.00
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MAGNET AND STABILIZER CAVITY For 2J41 Magnetron $24.50
90 degree elbows, "E" or "H" plane 2½" radius. $8.50
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ADAPTER, UG-163/U round cover to special BTL Flange for TS-45, etc..... $2.50 ea.
TS-12 SWR Measuring set slotted line accessory amplifier. 8000-10,000 M.C., New..... $425

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Model 15: 30 Mc Center frequency, Bandwidth 2.5 Mc. gain figure; 65 db. Uses 5 stages of 6AC7's. Has D. C. Restorer and Video Detector A.F.C. Strip included. Input impedance: 50 Ohms. Less tubes $17.50
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UG 39/U	$1.10	UG 51/U	$1.85
UG 40/U	$1.25	UG 52/U	$3.40
UG 40A/U	$1.85	UG 52A/U	$3.40

3 CM. TEST SETS

TS 12/AP. For standing wave measurement of slumbing, TR/ATR boxes, crystal mixers, antennas, etc. The TS 12 consists of two basic units: Unit 1 is a high gain stable amplifier followed by a 3-inch meter which reads SWR directly. UNIT 2 consists of waveguide accessories, including a slotted line, probes, dummy load, adapters, etc. Either bolometer or crystal input may be used. Both units are portable, self contained. Operates from 115 v. 60-800 cps. New*
TS 13/AP. Signal source 9305-9445 mc, 50 microwatts. Comes with a wavemeter, thermistor-bridge power meter, and calibrated attenuator. Oscillator is a klystron type 723/a-b which may be internally (self-synch) or externally pulsed. Controls are provided for FM operation, variable pulse delay, pulse width and phasing. Operates from 115 v, 60-800 cps. New*
*Send for pricing and delivery schedules

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AT49/APR—Broadband Conical, 300-3300 MC. Type N Feed $8.95
Discone Antenna. AS 125 APR. 1000-3200 mc. Stub supported with type "N" Connector..... $14.50
AS14A/AP, 10 CM pick up dipole assy. complete w/ length of coax and "N" connectors..... $4.50
AS46A/APG-4 Yagi Antenna, 5 element array..$22.50
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LP-24 Alford loop, for use with glide-path transmitters (MRN-1, etc.) 100-108 mc..... $32.50
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COMBINATION—115V/60~INPUT

CT-127	900V/25MA PK. 5V/2A, 2V/7.5A	2.75
CT-906	350-0-350V/120MA, 5VCT/1A, 2.5VCT/12.5A, 2.5VCT/3.5A	4.39
CT-965	700V/0.6A, 6.3V/2A	1.95
CT-804	350-0-350V/90MA, 5VCT/1A, 2.5VCT/12.5A	4.60
CT-902	350-0350V/50MA, 5VCT/2A, 2.5VCT/7.5A	3.65
CT-475	7000V .018V, 2.5V 5A /17,000 V. Test!	22.50
CT-913	450-0450V @ 200MA, 10V/1.5A, 2.5, 3.5A, 5V/3A	4.35
CT-403	350VCT .026A 5V/3A	2.75
CT-931	585VCT .086A 5V/3A, 6.3V/6A	4.25
CT-929	4280V/.001A, 2.5V/2A, 6.3VCT/.8A	5.35

PLATE—115V/60~INPUT

PT- 07	400VCT/4.0 AMPS For RA43	17.50
PT 034	125V/45MA (For Preamp)	.79
PT 371	210-0-210V at 2.12 Amp.	5.49
PT 133	3140/1570V, 2.36KVA	85.00
PT 801	22-086V/234 MA., 5.35 KVA	115.00
PT 521	7500V/.06A, Half Wave	59.50
PT 913	2580V/12 MA H'SLD	4.95
PT 12A	280VCT/1.2A	1.95
PT-38-2	37.5/40V AT 750 MA	2.15

FILAMENT—115V/60~INPUT

FT-157	4V/16A, 2.5V/2.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25A/21A, 2x7.75V/6.5A	14.95
FT-424	2x26V/2.5A, 10V/1A, 1.2V/7A, 6.4V/10A 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/1A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-38A	6.1V/2.5A, 2x2.5V/7A 5KV Test	2.75
FT-650	2.5/10A-1KV TEST 1.0-CAP	7.50
FT-025	2.5VCT/10A, 10KV TEST	6.95

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
BDAR3	14		375	.150	$6.50
35X-059	19	1.8	485	.095	4.35
POSX-15	14	2.8	220	.08	8.95
DM33A	28	7	540	.250	3.95
23350	27	1.75	285	.075	3.95
B-19	12	9.4	275	.110	6.95
			500	.050	
DA-1A*	28	10	300	.260	3.95
			150	.010	
			14.5	S.	
PE 73CM	28	19	1080	.350	12.50
BD 68†	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.04	2.50
BDAR 93	28	3.25	375	.150	6.95

‡ Less filter. * Replacement for PE 94.
† Used, Excellent.
PE 94, Brand New 5.95

INVERTERS

800-1B Input 24 vdc, 62 A. Output: 115 V, 800 cy, 7A, 1 phase. Used, excellent $18.75
PE-218M: Input: 25/30 vdc, 92 amp. Output 115V 500 cy (500 Volt-ampere. NEW $32.50
PE206: Input: 28 vdc, 36 amps. Output: 80 V 800 cy. 500 volt-amp. Dim. 13 x 5½ x 10½. New ..$22.50
EICOR—ML 3011-5. Input: 13.75 V; 18.4A. Output: 115 V/400~, 3ϕ, 0.95 PF. New $59
PU 7/AP: Input: 28 vdc/160A. Output: 115 VAC, 400~, 1ϕ, 500 VA., 21.6 Amp. Volt, and Freq. Reg. Used, Exc. $75

PULSE NETWORKS

H-605: 25 KV, 1.5 usec. Type "E" Network. 400 PPS, 50 ohms Z. $62.50
7-5E3-1-200-67P, 7.5 KV "E" Circuit, 1 microsec, 200 PPS, 67 ohms Impedance 3 sections..... $7.50
7-5E4-16-60, 67P, 7.5 KV "E" Circuit, 4 sections 16 Microsec, 60 PPS, 67 ohms Impedance..... $15.00
7-5E3-3200-67P, 7.5 KV. "E" Circuit, 3 microsec, 200 PPS, ohms Imp. 3 sections..... $12.50
H-616 10KV, 2.2 usec., 375 PPS, 50 ohms Imp. $27.50
H-615 10KV, 0.85 usec., 750 PPS, 50 ohms Imp..$27.50
KS8865 CHARGING CHOKE: 115-150 H @ .02A, 32 40H @ .08A, 21 KV Test..... $37.50
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G.E. 6E3-5-2000, 50 PPT; 6KV., "E" Circuit 0.5 usec /2000 PPS/50 ohms/2 sections..... $7.50

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MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp.) Duty Ratio: .001 max. Pulse duration: 5, 1.0, 2.0 microsec. Input voltage: 115 v, 400 to 2400 cps. Uses: 1-721B, 4-80-H, 3-72B's, 1-72. New ..... Less Cover—$135
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Airborne RF head, model A1A, delivers 80 Kw peak output at 9000 mc. at .001 duty. Complete with pulser unit and all tubes..... $185.00

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RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC: 16KV-16 AMP DUTY RATIO: 001 400 CYCLE FIL. TRANS. "BUILT-IN"..... $42.50
WECO: D-163247 For Modulator of SCR 720..$22.50
4P37 (West'h'se). Pri: 50 ohms 750V. Sec. 15 KV/1000 ohms .001 Duty. Bifilar: 12.6V/2.5A..... $32.50
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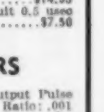
Primary: 0.33 KV, 50 ohms Imp.
Secondary: 20 KV, 450 ohms.
Pulse length: 1.05/5 usec @ 635/120 PPS, PK Power Out: 1,740 KW
Bifilar: 1.5 amps (as shown)..... $62.50



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UTAH X-1507-1: Two sections, 3 Wdgs. per section, 1:1 Ratio, 5 MH, 6 ohms DCR per Wdg.... $5.00
6BG711: Ratio: 4:1 Pri: 200V, Sec. 65V, 1.0 usec Pulse @ 2000 PPS, 0.016 KVA $4.50
TR1049 Ratio 21 Pri. 220 MH, 50 Ohms, sec. 0.75 H, DCR 100 Ohms..... $6.75
K-904695-501: Ratio 1:1, Pri. Imp. 40 Ohm. Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise $6.95
RAYTHEON, UX-7350, UX-7307 ..... 95. ea.

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KS9615	6.3V/4A, 3V/1A	1.67
KS9318	6.3V/4A, P/O R-55/ARO-9	1.35
KS9668	1233/.35MA, 1140VCT/.07A	6.79
352-7102	6.3V/2.5A	1.45
M-7472426	1450V/1.0MA, 2.5V/.75A, 6.4V/1.9A, 5V/2A, 6.5V/.3A, P/O ID-19/APG-33	4.95
35 -7039	640VCT @ 180MA, 6.3V/.9A, 6.3V6A 5V/6A	5.49
787724	9800/8000 @ 12MA	9.95
KS9584	5600V/.90MA, 5V/10A	22.50
KS9687	734VCT.177A, 1710VCT/.177A	6.79
352-7273	700VCT/150MA, 6.3V/0.9A, 6.3V/2A, 6.3V/.09A, 5V/CA	6.95
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352-7196	1140/1.25MA, 2.5V/1.75A,2.5V/1.75A—5KV TEST	3.95
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901692	115V/9A	2.49
901695-501	2.77V @ 4.25A—10KV Test	1.45
901698-501	900V/75MA, 160V/.04A	4.29
Ux8855C	900VCT/.047A, 5V/3A	1.79
352-7096	2580V/65MA, 240VCT/135MA	5.95
KS9338	110V/50MA TAPPED 625V 2.5V/5A	3.95
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KS8984	27V/4.1A, 6.3V/2.9A, 1.25V/.82A	2.95
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Control includes breaker, plate and grid meter and interval timer

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1N21B 1.50
1N23 ..... .75
1N23B 1.75
1N23BM ... 5.00
1N25 ..... 4.00
1N26 ... 4.95
1N34A ..... .60
1N35 ..... 1.50
1N48 ..... 8.00
1N47 ..... 4.50
1N63/K63 .. 1.75

2E32 ..... 1.00
2J21A 3.00
2J22 ..... 3.00
2J26 ..... 5.00
2J27 ..... 5.00
2J31 ..... 15.00
2J32 ..... 15.00
2J33 ..... 15.00
2J34 ..... 15.00
2J36 ..... 20.00
2J42 ..... 60.00
2J48 ..... 40.00
2J49 ..... 40.00
2J50 ..... 35.00
2J51 ..... 150.00
2J55 ..... 35.00
2J56 ..... 50.00
2J61 ..... 15.00
2J62 ..... 5.00

3C27 ..... 1.50
3C31 ..... 2.50
3C33 ..... 9.95
3C45 ..... 7.00
3DP11A ... 7.50
3D21A 5.00
3E29 ..... 9.50
3GP1 ..... 1.95
3J30 ..... 35.00
3J31 ..... 45.00
3K30 ..... 125.00
4B23 ..... 10.00
4B24 ..... 7.50
4B26 ..... 3.50
4B27 ..... 4.00
4-125A ... 17.50
4C27 ..... 3.50
4C28 ..... 25.00
4C35 ..... 15.00
4E27 ... 9.00
4J22 ..... 45.00
4J23 ..... 45.00
4J24 ..... 45.00
4J26 ..... 75.00
4J27 ..... 40.00
4J28 ..... 40.00
4J29 ..... 50.00
4J31 ..... 65.00
4J34 ..... 50.00
4J42 ..... 25.00
4J50 ..... 85.00
4J51 ..... 150.00
4J52 ..... 50.00
4J57 ..... 149.00
4X150A ... 25.00
4X500A ... 60.00
5BP2A 6.50
5BP4 ..... 2.00
5CP1 ..... 1.75
5CP1A 10.00
5C22 ... 29.50
5C30/C5B ... 1.50
5CP7 ..... 7.50
5D21 ..... 7.00
5D23 ..... 7.50
5FP7 ..... 1.50
5FP14 ..... 5.00
5JP2 ..... 7.50
5JP4 ..... 7.50
5JP5 ..... 7.50
5JP11A ... 17.50
5J23 ..... 20.00
5J29 ..... 7.00
5J30 ..... 7.00
5J33 ..... 5.00
5MP1 ..... 3.95
5NP1 ..... 5.00
5R4GY 1.00
5R4WGY ... 2.40
C6J 6.50
C6L/5528 .. 4.00
6AC7A ..... .90
6AC7W 1.25
6AJ5-JAN . 1.25

6AL5W ..... .85
6AR6 ..... 1.30
6AS7G 2.00
6D21 ..... 200.00
6F4 ..... 3.25
6J4 ... 3.50
6K4 ..... 2.50
6L6WGB ... 3.50
6SL7WGT .. 2.00
6SN7W 2.00
7C22 ..... 50.00
7C23 ..... 69.50
7C24 ..... 100.00
15E 1.00
NE16 ..... .35
RK21 ..... 1.00
HK24 ..... 3.00
28D7 ..... .90
T40 ..... 2.50
D42 ..... 40.00
HK54 ... 2.00
QK59 ..... 30.00
QK60 ..... 25.00
RK60/1641 . 1.95
QK61 ..... 30.00
QK62 ..... 29.50
HY65 ..... 2.00
RK65/5D23.10.00
FG67/5728 10.00
RKR72 ..... .50
RKR73 ..... .50
FG104 ..... 29.50
FG105 ..... 12.50
F123A 4.00
F128A 20.00
HF100 ..... 7.50
FG154 ..... 17.50
VT158 ..... 10.00
FG166 ..... 17.50
FG172 ..... 17.50
WL200 ..... 75.00
203A 5.00
204A 35.00
207 ..... 50.00
211/VT4C ... .50
212E 17.50
217A 2.00
217C 2.00
WL218 ..... 25.00
QK221 ..... 125.00
FG235A ... 35.00
QK249 ..... 150.00
249B 3.00
249C 3.00
250R 5.00
250TL 15.00
251A 50.00
252A 10.00
QK253 ..... 149.50
254A 6.50
FG258A ... 130.00
271A 10.00
274B 1.00
282B 5.00

305A 3.50
307A/RK75 . 1.00
312A 2.95
313C 3.00
316A ..... .50
323B 5.00
327A 2.50
336A 5.00
338A 5.00
349A 7.50
350A 3.00
350B ... 2.75
354A 15.00
354C 5.00
368AS 3.00
388A 1.20
393A 4.50
394A 3.00
396A 3.25
403B/5591 . 2.75
WE417A ... 13.50
WL417A 4.00
WE418A ... 15.00
WE421A ... 15.00
WE422A ... 11.00
RT434 ..... 25.00
434A 3.00
446A ..... .50
446B 2.00
450TH 35.00
450TL 35.00
WL456 ..... 59.50
464A 2.50
CK512AX .. 1.10
527 ..... 15.00
ML531 ..... 4.00
559 ..... .50
KU610 . 5.00
HY615 ..... .50
WL616 ..... 99.50
KU627 ..... 10.00
631P1 ..... 7.00
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WL651 ..... 39.50
WL652 ..... 25.00
WL681/6862 7.50
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703A 1.50
704A 1.00
705A 1.00
706AY-GY 15.00
707A 3.50
707B 5.00
708A 1.00
713A ..... .50
714A 12.50
714AY 20.00
715A 2.00

715B 5.00
715C 12.00
717A ..... .75
719A 10.00
720AY-EY. 25.00
721A ... 1.00
721B 7.50
722A ..... .75
723A/B ... 8.50
724A 1.00
724B ..... .75
725A 3.50
726A 7.00
726B 25.00
726C ... 25.00
730A 10.00
750TL 45.00
801A ..... .50
802 ..... 2.75
803 ... 1.50
804 ..... 9.75
805 ..... 4.75
806 ..... 9.50
807 ..... 1.25
807W 4.50
808 ..... 1.50
808 ..... 2.75
811A 3.50
812 ..... 2.50
813 ..... 11.00
814 ... 2.00
815 ..... 1.50
816 ..... 1.50
828 ..... 8.50
829 ..... 6.00
829B 8.50
830B ..... .95
832 ..... 4.00
832A 6.00
833A 27.50
836 ..... 2.00
837 ..... 1.00
838 ... 1.00
845 ..... 6.00
846 ..... 75.00
849 ..... 24.50
851 ..... 12.50
852 ..... 5.00
860 ..... 3.50
861 ..... 15.00
865 ..... .50
866A 1.15
872A 1.50
874 ..... .60
878 ..... .60
884 ..... 1.25
GL889 ..... 60.00
GL889A ... 74.50
889RA ... 150.00
902A 3.50
902P1 ..... 3.50
919 ..... 2.50
922 ..... 1.25

923 ..... 1.50
927 ..... 1.40
SN930 ..... 4.50
931A ... 2.75
935 ..... 4.00
SN944 ..... 4.50
SN949C ... 4.50
SN953D ... 4.50
954 ..... .35
955 ..... .40
956 ..... .40
957 ..... .40
958A ..... .50
959 ..... 1.50
SN977CX .. 4.50
991 ..... .35
CK1005 ... .35
CK1006 ... 2.75
1500T 85.00
1603 ..... 3.50

5663 ..... 1.50
5667 ..... 150.00
5670 ..... 2.00
5672 ..... 1.25
5675 ..... 7.00
CK5678 ... 1.00
5686 ..... 2.00
5687 ..... 3.00
5691 ..... 5.00
5692 ..... 5.00
5693 ..... 4.75
5696 ..... 1.10
5702 ..... 2.00
5703 ... 1.25
5718 ... 3.00
5719 ..... 2.50
CK5721 ... 189.50
5725 ..... 2.00
5726 ..... 1.00
5727 ..... 2.25
5744 ..... 1.00
5750 ..... 3.10
5751 ..... 2.20
5780 ..... 199.50
CK5787 ... 4.95
5814 ..... 1.60
5842 ..... 13.50
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2C35 ..... 2.50
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2C52 ..... 3.50
2C53 ..... 10.00
2D21 ..... 1.00
2D21W 1.50
2E22 ..... 2.00
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2K26 ..... 45.00
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2K33A 65.00
2K34 ..... 99.50
2K39 ..... 125.00
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2K44 ..... 150.00
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2K48 ..... 90.00
2K54 ..... 15.00
2K56 ..... 50.00
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3B28 ..... 6.00
3B29 ..... 6.95
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3C23 ..... 3.75
3C24 ..... 1.50

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1620 ..... y 3.50
1623 ..... 2.50
1624 ..... 1.00
1625 ..... .30
1626 ..... .35
1630 ..... .50
1631 ..... 1.75
1636 ..... 1.25
1641 ..... 1.50
1649 ..... .50
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2051 ..... .70
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5654 ..... 1.50
5656 ..... 7.50
5657 ..... 125.00

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5899 ..... 7.00
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2D21	1.00
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2E26	2.40
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4E27A	9.00
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4J28	14.00
4J29	34.50
4J26	59.50
4J27	59.50
4J28	59.50
4J29	59.50
4J30	69.50
4J31	49.00
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7C22	49.50
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7BP1	6.99
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7LP7	1.50
10Y-	.31
12A5	1.66
12AH8	1.00
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24B	1.00
257G	1.44
43A	2.50
89Y	.10
100TH	8.99
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203A	19.49
203B	.80
207	49.50
211	1.50
212	1.50
217A	1.49
217C	3.99
231D	1.19
241C	7.99
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259A	9.99
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276A	1.49
276B	1.99
276C/B	5.50
285A	7.46
287A	6.61
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307A/RK75	.99
310A	3.00
316A	1.46
327A	1.49
328A	4.69
350A	4.99
350B	4.99
371B	1.00
388A	1.49
393A	1.45
394A	4.99
417A	6.99
434A	3.99
446A	1.49
446B	1.20
WL-446A	9.99
WL-446A	7.50
GL-471A	2.25
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704A	1.99
705A	1.99
706B	10.95
706C	15.95
707A	1.95
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709A	1.19
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721A	1.29
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722	1.99
723A/B	1.99
724A/B	1.29
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726B	26.50
726C	26.50
739A	9.99
801	.89
801A	4.99
802	2.00
803	1.99
804	1.99
805	4.25
806	10.50
807	5.00
808	1.99
810	1.99
811	1.99
813	9.75
814	1.99
815	1.99
816	1.99
826	1.99
828	9.75
829B	10.49
830B	1.95
832A	8.49
833A	17.49
836	2.99
837	.99
838	1.99
841	.26
843	.49
845	7.49
860	12.50
861	12.50
864	14.99
864	.29
865	1.19
866A	.99
869B	15.99
872A	3.25
874	.74
876	.74
878	1.29
884	.99
885	1.49
9-3	.69
902A	1.99
918	2.18
927	1.95
931A	2.99
954	.26
955	.49
956	.59
958	.59
959	.59
958	.59
958	1.49
991	.59
1066T	34.50
CK1005	6.50
CK1006	2.49
1608	2.99
1613	.99
1614	1.99
1616	.99
1622	1.49
1624	1.39
1625	.99
1626	.31
1629	.32
1630	.49
1632	.49
1634	.49
1635	.49
1641	2.49
1642	.39
1644	.49
1644P1	1.99
1851	1.39
1852	1.99
1960	1.10
2050	1.49
2050W	1.49
2051	.89
2A1	.89
2B1	.89
2G6GT	.89
2C5	.94
2LD5	.94
2L4	.89
2T1	.89
2A5	.79
2A6	.89
2N5	.89
2R5	.89
2S4	.89
2S5	.89
2U4	.89
2U5	.89
2X2A	.89
2V3	.89
2B7	.89
2A7	.89
3V4	.73
3Q4	.89
3S4	.89
3U4	.89
5Y3	.89
5Y4	.89
5V4	.89
5Z4	1.19
5W4	.89
6AC7	.89
6AC7W	1.49
6AB7	.99
6AF4	1.20
6AG5	1.10
6AG7	1.10
6AH6	.89
6AL5	.89
6AJ5	1.69
6AK5	.74
6AL7	.89
6AN4	1.35
6AQ6	.89
6AQ8	1.50
6AS5	.74
6AS7G	2.99
6AT4	1.49
6AU6	.89
6BA7	.89
6BE6	.89
6BG6G	1.99
6BH6	.79
6BJ6	.89
6BK7A	1.25
6BL7	1.49
6BM6	1.99
6BN6	1.24
6BQ6	1.19
6BQ7A	1.19
6BX7	1.24
6CD6	1.25
6CB6	.69
6C4	.48
6C5	.49
6C6	.49
6CG7	.99
6CH6	.79
6CL6	2.49
6CM5	.79
6CW5	.79
6D6	.69
6F5	.69
6F6	.69
6F6G	.69
6J4	1.29
6J5	.69
6J7	.94
6J8	.94
6K4	2.49
6K6	.79
6K7	.69
6K8	.89
6K8G	1.19
6K8GT	.89
6L6	.99
6L6GM	1.49
6L6G	.99
6L7	.99
6N7	1.19
6N7GT	.69
6S4	.59
6SC7	.74
6SG7	.59
6SH7	.59
6SK7	.64
6SL7	.79
6SN7	.79
6SS7	.79
6W6	.69
6V6	.69
6V6GT	.69
6X4	.49
6X5	.69
6Y6	1.19
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7A4	.79
7A5	.89
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7A8	.69
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14W7	.89
14X7	.89
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25L6	.64
25Z6	.64
26D6	1.75
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35A5	.89
35L6	.89
35Z5	.69
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Uses (6) 6AK5 Mfg. Western Electric. Price, $14.50.

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MIT type TS155 Signal Generator. 2C40 precision lighthouse cavity 2700-2900mc, wg below cutoff varia. attenuator, power meas. thermistor bridge, 115vac regulated pwr. supply. Excellent cond. $325.00.
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2 phase; 26 volts; stalled torque .5" oz.; speed 3460 rpm; reversing time 0.4 seconds; weight 6 oz.; length 1¾"; Pioneer Instrument.

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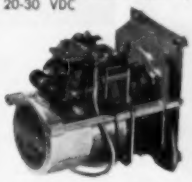
DC TIMING MOTOR

with chronometric governor adjustable from 1 to 25 min. mfgd. by Haydon 20-30 VDC



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OUTPUT: 115 V; 3-phase; 400 cycle; Amps .5; INPUT: 24 VDC; 12 amp. $69.50

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Output: 26 volts; 3 phase; 400 cycle; 10 VA; .6 PF Input: 27.5 volts DC; 1.25 amps ...$24.50

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24-30 volts input; 5.5-45 amps; cont. duty. Output: 115 volts; 44 amps; 400 cyc; 1 phase; PF 1.0; 50 watts $39.50

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Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 PF. Input: 27.5 DC; 12.5 amps; cont. duty ...$90.00

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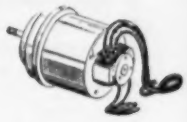

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SIMPLE DIFFERENTIAL

Size: 2-5/32" long x 1⅛" dia.; bearing one end ½" O.D.; Shaft Size: 1" long, threads 8-32-¾" long, with bearing shaft ⅛" dia. x ¼" long. Gear on shaft end 1-7/16" dia., gear on bearing end 1¼" dia. Drive gear 25/32" dia.

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SPIDER DIFFERENTIAL

Size: 6½" long x 1¾" wide with 3/16" shaft.

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DUAL SIMPLE DIFFERENTIAL

1:1 reverse ratio on both. Size: 3¼" long x 1-7/16" dia. Shaft size: ⅛" and 3/32".

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SIMPLE DIFFERENTIAL

1:1 reverse ratio. Size: 6¾" long x 2¾" dia. Shaft size: 11/32".

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SIMPLE DIFFERENTIAL

Size: 5½" long x 2¼" dia. Shaft size: ⅜" on one end and 11/32" on other end. Hub is 1-3/32" dia. on each end.

$7.50 ea. *Stock No. 112*

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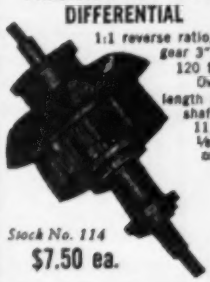
1:1 reverse ratio, ring gear 3" dia., 120 teeth. Overall length 5¼", shaft dia. 11/32", ⅛" key on one end.



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Automatic ground direction finder covering 1.5mc-30mc. Provides instant bearings on a C.R. indicator of any signal in its range. This equipment is transportable and can be set up quickly. 110v 60 cyc. POR.

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We can supply the following types of remote Radar P.P.I. Repeaters. The main radar provides the Synoronizing, Synoro, and Video. Pulses to operate the Repeaters. These repeaters may be used with any marine ground or airbourne.

VC 7" P.P.I. Upright desk mount Repeater. 4 Ranges are provided from 4-200 miles. Input 110 Volt 60 Cyc.

VD 7" P.P.I. Desk mount Repeater. This unit is very similiar to the VC but is completely Waterproof and may be used on deck. The ranges are the same as the VC. Input 110 Volt 60 Cyc.

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VF 9" P.P.I. Desk mount Repeater. This is a very late model Repeater enabling 20 radars to be fed into it. 4 Ranges from 4-200 miles are provided. Input 110 Volt 60 Cyc.

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Accessories are available such as repeater adaptors enabling the set to be used at a greater distance than normal. Input switches to select the radar to be viewed etc.

SCR-682-A RADAR
10CM high power long range harbor surveillance and early warning RADAR. This equipment is a 3000 mc mobile search radar that can be transported in a truck. The equipment incorporates a 7" PPI for operation up to 240,000 yards. Azimuth accuracy is ± 1%. Range accuracy is 100 yards at 10,000 yard range and 5000 yards at 240,000 yard range. Trans. output is approx. 225 KW. pulse width is one microsecond. Antenna beam width is 6°. Input is 110v 60 cyc. Can be supplied with or without operating shelter or antenna tower. POR.

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This is a precision receiver covering 38-4000 mc. The set utilizes 8 tuning units with direct reading dials in megacycles. The receiver has a wide and narrow band-width 30mc. I.F. strip which may be selected at will. An output meter is provided to measure signal strength. Outputs are provided for a pulse analyzer and pan adaptor. Each tuning unit has an automatic sweeping mechanism which enables any portion of the tuning range to be scanned automatically. Input 110v 60 cyc. POR.

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This is a high precision signal generator covering 500-1300 mc. A precision attenuator is built in providing accurate determination of output from 0-100,000 microvolts. Either CW or pulsed carrier output with the following characteristics are provided. Pulse rate 60-2,500 CPS. Pulse length 2-30 microseconds. Output line 50 Ohm impedance. Accuracy better than one percent. Input 110 v 60 cyc. With calibration charts. Price $249.50

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CF-3A CARRIER REPEATER
This is a transportable 4 wire carrier telephone repeater. This set amplifies all signals when used in an intermediate position on a carrier system to extend the range. DC signaling and telegraph communications can be performed to the terminal equipments or to other repeaters. Monitoring and transmission circuits are built in. Power input 110 or 220v or 12v DC. This set can be used with all CF terminals and commercial equipments. Brand New in original cases. POR.

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AN/CPN-8 S-BAND HIGH POWER Airport Beacon. This is a very compact set. This set will interrogate S-BAND Radars up to 200 Miles. Variable Coding and monitoring facilities are provided. Input 110 Volt 60 Cyc.

AN/CPN-17 S-BAND High power version of the CPN-6 with all the latest improvements. Input 110 Volt 60 Cyc.

AN/UPN-4 X-BAND Very lightweight Portable Beacon. This set will interrogate X-BAND Radars up to 60 miles. Variable Coding is provided. Input 12 Volts D.C. Weight Approx. 40 Lbs.

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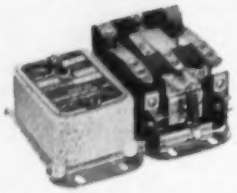

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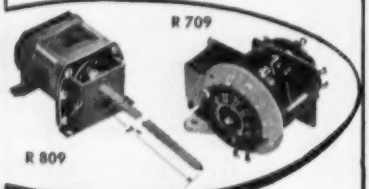

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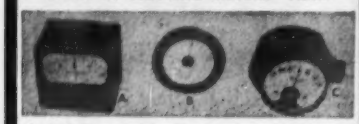

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CONDENSERS

10 mfd. 600 V . . . . . $.89

Three term. bot. mntg. channel type. Dims. 3¾"x3½"x2". Two 5 mfd. sections rated 400 V at 72 deg. "C". 1800 V test. Meets commercial specs. for 600 V operation up to 40 degs. "C". Ideal for filter or power factor application where ruggedness and quality are paramount. Carton or 24 weight 42 lbs. **$.79**

16 mfd.—600 V $1.89

Dual 8 mfd oil filled cond. hermetically sealed and packed. Tobe type PT-SC-11 measuring 3¾"x2⅝"x2⅝". Stud mntg. centers 2". Plugs into standard four prong socket.

4 mfd.—600 V . . . . . $.98

Type TLA Inverted cylindrical cap. sing. term. Mounts through ¾" hole in chassis. Hardware included. Factory cartons.

- OTHER ITEMS AVAILABLE -

MICA CONDS.
BATHTUB CONDS.
CHANNEL CONDS.
RHEOSTATS
POTENTIOMETERS

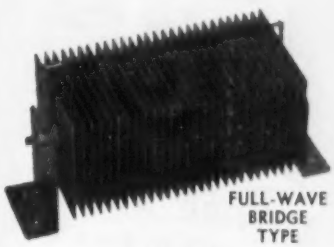
Mfd.	Volts	Price
.001	60KV	24.95
.0028	16KV	6.95
.01	5000	.79
.01	10KV	4.95
.012	25KV	12.96
.02	8000	4.75
.02	10KV	5.25
.02	20KV	10.95
.025	50KV	22.95
2X .026	50KV	34.50
.03	7500	4.50
.035	15KV	5.95
.06	7500	2.95
.4	12.5KV	8.95
.1	1500	.39
.1	2000	.45
.1	2000	.49
.1	2500	.98
.1	3000	.69
.1	3000	1.19
.1	7500	.49
.1	7500	4.26
.1	10KV	6.35
.1	12KV	6.95
2X .1	2000	.89
2X .1	7000	3.50
2X .1	6000	2.29
.2	10KV	8.50
.2	15KV	13.95
.2	60KV	39.50
3X .2	4000	2.85
.25	1500	.88
.25	2000	.98
.25	3000	1.45
.25	4000	1.98
.25	6000	.95
.25	20KV	16.95
.25	25KV	49.00
.25	32KV	49.50
.25	50KV	62.95
.3	2000	.59
2X .35	2000	1.10
.4	10KV	10.00
2x .4	7500	5.25
.5	1500	.69
.5	2000	1.19
.5	3000	1.49
.5	3000	2.39
.5	5000	3.95
.5	7500	6.25
.5- 1	2000	.39
2x .5	600	.69
2x .5	9000	12.95
.6	25KV	45.95
.66	12.5KV	13.95
1	600	.55
1	1000	.69
1	1500	.98
1	2000	1.88
1	2500	2.20
1	4000	2.95
1	5000	6.25
1	6000	5.95
1	6000	6.50
1	7500	8.95
1	7500	14.50
1	10KV	23.50
1	15KV	26.95
1	20KV	45.95
1	25KV	49.50
1	25KV	65.00
1	25KV	76.00
1	330AC	.65
1.75	600	.55
2	600	.65
2	1000	.98
2	1000TLA	1.29
2	1500	1.15
2	2000	2.80
2	2500	3.45
2	3000	4.25
2	4000	5.50
2	5000	12.50
2	7500	21.9
2	10KV	38.96
2	12.5KV	59.50
2	20KV	69.75
2x2	600	.85
3	1000	.98
3	2000	2.50
3	4000	8.95
2x3	150	.29
3x3	400	.69
4	500	.55
4	600	.79
4	600TLA	.98
4	1000	1.89
4	1500	2.65
4	2000	2.95
4	2500	4.95
4	3000	6.95
4	4000	13.95
4	5000	24.95
4	7500	34.95
4	10KV	59.95
4	220AC	1.19
4	330AC	1.19
5	600	1.19
5	1000	1.89
5	1500	1.98
2x5	400	.89
2x5	600	1.39
2x5	400	1.79
6	600	1.69
6	330AC	1.69
6	1000	2.10
6	1500	2.95
7	110AC	.79
7	600	.98
7	600	1.35
7	800	1.75
7	5000	29.95
8	500	.99
8	600	1.49
8	660AC	4.26
8	800	1.89
8	1000	2.78
8	1400	3.85
8	1500	3.65
8	2000	5.95
8	2500	6.50
2x8	600	1.89
10	440AC	.65
10	600	1.19
10	600	2.25
10	1000	2.75
10	1500	4.26
10	2000	5.95
10	2500	89.50
12	660AC	3.75
14	50	.99
14	330AC	3.50
15	400	5.25
15	440AC	3.85
15	1070	5.95
15	1500	5.40
16	5000	63.50
20	330AC	5.35
20	600	1.69
24	500	1.89
25	1000	5.95
30	330AC	5.25
30	2500	12.95
50	330AC	8.50
70	220AC	6.50
80	4000	45.50

WANTED

Oil & Mica Condensers in any quantity. Also other Standard Components. *Write: Art Hankins*

MONMOUTH RADIO LABS.

BOX 159 OAKHURST, N. J.
Capitol 2-2776



FULL-WAVE BRIDGE TYPE

DIRECTRON SELENIUM RECTIFIERS

Max. Amps.	18VAC 14VDC	36VAC 28VDC	54VAC 42VDC	72VAC 56VDC	130VAC 100VDC
1	$1.35	$2.35	$3.75	$4.50	$7.45
2	2.00	2.75	5.35	5.50	9.35
3	2.95	4.15	5.85	7.85	12.75
4	3.50	6.45	11.35	14.35	21.75
6	4.00	7.75	12.85	17.10	29.75
10	5.50	11.45	19.50	24.80	41.35
12	7.25	14.35	22.10	29.75	44.25
20	13.85	25.85	37.25	48.75	78.50
24	14.25	28.75	44.50	57.65	91.00
30	17.95	34.35	56.50	71.00	109.00
36	22.45	42.35	65.00	86.95	134.00
50	29.50	54.35	105.45	115.75	174.00
100	59.50	119.00			

We build other Selenium Rectifiers, Transformers, and Chokes to your specifications. Buy from the Direct Source for Quick Delivery.

NEW RECTIFIER TRANSFORMERS

Continuous Ratings
Pri: 115V, 60 cycles input
SEC: 9, 12, 18, 24, and 36 volts.

1 Amp	$5.75
2 Amps	6.75
12 Amps	16.65
24 Amps	35.65
50 Amps	59.00
100 Amps	100.00

NEW RECTIFIER CHOKES

Continuous Ratings

1 Amp	.1 Hy	1.5 ohm	$4.95
2 Amps	.04 Hy	.9 ohm	5.95
4 Amps	.07 Hy	.6 ohm	7.95
12 Amps	.01 Hy	.1 ohm	14.95
24 Amps	.004 Hy	.025 ohm	29.95
50 Amps	.005 Hy	.01 ohm	54.00

FILTER CAPACITORS

Capacity	W. Voltage	Each
500 MFD	200 V.	$1.95
500 MFD	50 V.	.85
1000 MFD	15 V.	.35
2000 MFD	50 V.	2.25

NOW AVAILABLE!
SUPER GLOSS RED & BLACK TUBE CARTONS

SIZE	EACH	SIZE	EACH
Miniature 1"x1"x2" 6AU6, 6AL5, etc.	$ .1½	LARGE GT 1½"x1½"x4½" 1B3, 5BQ6GT, etc.	.1½
GT 1¼"x 1¼"x3½" 6SN7GT, 6W4GT, etc.	.1½	LARGE G 2"x2"x6" 5U4G, 6BG6G, etc.	.2

Also in White Coated

Both types with new safety partitions—they meet U. S. Government specifications! Attractive discounts for quantity users. Minimum order 100 of a size. Be sure to specify white or color when ordering.

TRANSMITTING TUBE CARTONS

Small Jumbo White Only	Large Jumbo
3"x3"x7½" FOR 809, 866A, etc. $7.50 PER 100 550 TO THE CASE	4"x4"x10" FOR 813, 872A, etc. $10.00 PER 100 300 TO THE CASE

KILOWATT POWER SUPPLY

Matched, compact, hermetically-sealed components for KW power supply. Ideal for new Collins KWS-1K, etc.

- Power xfmr. Pri: 115 v. 60 cy. with taps for ⅛, ⅓, and full power. Sec: 3400 v. @ 400 ma. 39 lbs.—8"x5⅝"x7½".
- Choke to match above—12 henries @ 400 ma. 34 lbs. 8"x5⅝"x7½".
- Filament xfmr for 4—866A's in bridge circuit. Pri: 115 v. 60 cy. Sec: 2.5 v. @ 5.0 A, 2.5 v. @ 5 A., and 2.5 v. @ 10 A. Complete set of above 3 items only $45.00

Terms: F O B—N Y C—25% Deposit with order—or send full remittance to save C O D charges—D & R Rated Firms (F2½ or Better) Net 10 days. CABLE: BARRYLECT, N. Y. TELEGRAPH: BARRY ELECTRONICS, FAX, N. Y. C.

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QUALITY ELECTRONIC TUBES

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NEW, FREE RECEIVING TUBE CATALOG JUST OFF PRESS!

• Critical Types Lab Tested for Your Protection

OA4G	$1.00	QK61	25.00	872A	1.50
OB3/VR90	.85	QK62	25.00	872A(G.E.)	2.75
OC3/VR105	.85	FG67	12.00	874(RCA)	.60
OC3W	3.00	QK69	25.00	876(RCA)	.85
OD3/VR150	.85	QK72	25.00	891	125.00
1B24A	15.00	RKR-72	.50	902/902P1	6.00
1B26	1.50	RKR-73	.50	931A	3.00
1B32	2.00	90-NB		932	1.25
1B35	6.50	Amperex	7.00	958A	.50
1B63A	22.50	FG98A	20.00	1619	.30
1B85	9.95	100R Surplus	5.00	5516	6.50
1B86	7.75	100TH	6.75	5517	2.15
1N21	.06	100TL Surplus	8.50	5633	8.00
1N21A	.50	FG105	15.00	5634/SD628E	7.00
1N21B	1.50	VT127A	2.50	5637	5.50
1N22	.50	VXR130	.75	5638	8.00
1N23B	1.50	FG172	45.00	5641	6.00
1N26	4.50	QK181	35.00	5642	1.00
1N27	.75	203A	2.50	5654	1.65
1N34A	.65	204A	00.00	5656	6.50
1N35	1.50	207	45.00	5670	1.75
1N38A	.85	211/VT4C	.50	5672	1.25
1N48	.40	212E	15.00	5676	1.00
1N56	.85	227A	2.00	5678	1.15
1N64	.70	249A	3.50	5686	2.00
1N65	.75	251A(WE)	45.00	5687	3.00
1N69	.60	HK253	7.50	5691	5.50
1N70	1.20	266B	45.00	5692	5.25
1N81	.90	272A	9.00	5693	4.75
1N82	.70	274B	1.00	5696	1.15
1P30	2.00	275A	3.50	5702	2.00
2E30	1.60	276G	8.50	5703	.95
2E35	1.95	287A	3.00	5704	1.90
2J36	35.00	GL299	3.50	5718	4.25
2J32	15.00	300B	6.00	5726/6AL5W	1.10
2J37	10.00	304TH		5732	3.00
2J64	35.00	Surplus	8.75	5744	1.00
2K25	22.50	304TL		5751	2.50
2K28	28.50	Surplus	10.75	5763	1.10
2K45	65.00	311A	5.50	5780	250.00
2K55	17.50	311C	2.50	5787WA	5.75
3B24	1.50	337A	6.50	5794	7.75
3B24/W	5.00	350A(WE)	3.00	5795	250.00
3B27	3.50	WE355A	17.50	5812	2.75
3B28	6.00	359A	2.00	5814	1.50
3B29	6.00	361A	3.50	5814A	2.00
3C23	7.50	417A Klystron	3.50	5815	49.95
3C31/C1B	2.25	429A	8.75	5820	Write
3C45	7.95	464A	2.55	5829	2.00
3D21A	4.50	CK503AX	1.00	5840	5.00
3J30	45.00	GL559	.50	5841	7.50
3J31	45.00	GL562	50.00	5844	4.00
3BP1	2.95	WL651/5552	50.00	5879	1.40
3BP11	7.00	WL-653B	110.00	5881	2.65
3DP1	3.00	GL673	13.00	5886	.275
3FP7	2.50	703A	1.25	5890	35.00
4B24	5.00	705A	.85	5963	1.20
4B26 6 Amp Rectigon	3.00	707A	4.00	5993	10.00
		707B	5.00	6021	5.00
4C35	13.50	708A	2.00	6073	1.65
4E27	9.50	709A	1.75	6095	1.25
4J21	77.50	715B	3.95	6096	1.50
4J36	75.00	717A	.50	6097	1.50
4J37	75.00	721A	.75	6098	1.90
4J63	7.00	722B	1.00	6099	1.50
4PR60A		723A/B	9.50	6100	5.50
Surplus	75.00	726A	4.50	6161	1.50
4-125A		726B	25.00	6112	9.00
Surplus	19.00	726C	35.00	6136	4.00
4X150A		750TL	write	6189	4.50
Surplus	24.00	800	2.00	8000	9.50
4X150G	35.00	803	2.00	8020 Surplus	1.25
4X500F		807	1.25	8098/ RCA872A	4.00
Surplus	65.00	808	1.50		
5BP4	3.95	809	2.25	8013A	3.60
5C22	29.95	810	8.95	9001	.75
5D21	7.75	814	2.00	9002	.50
5JP5	10.00	816	1.15	9003	.95
5D21	85.00	838	1.00	9004	.25
10	.75	845	5.00	9006	.25
RK60	1.00	857B	17.50	•	
RK61	2.75	860	3.50	AND OTHERS . . .	
QK60	25.00	866A	1.25	WRITE	

BARRY ELECTRONICS CORP.

512 Broadway, New York, 12, N. Y.
Dept. 9 E

BRAND NEW GUARANTEED

POWER RHEOSTATS

Ohm	Watt	Each	Ohm	Watt	Each	Ohm	Watt	Each
1	150(L)	6.54	25	75	7.49	500	75(G)	3.15
.25	50	1.98	25	75(G)	4.72	500	100(K)	3.55
.5	100(K)	3.79	25	80	6.51	500	150(L)	5.05
1	150(L)	6.54	25	75(G)	5.27	500	200	6.28
1	25	1.76	25	100	5.27	500	300(N)	8.42
1	50	1.98	25	100(K)	3.66	575	150(L)	5.05
1	50(J)	2.50	25	150	5.05	750	25	1.98
1.5	50	1.98	50	25(H)	1.86	750	25(H)	1.86
2	25	1.76	50	50	1.86	750	150	4.25
2	25(H)	1.86	50	50	1.49	750	100(K)	3.55
2	50(J)	2.50	75	25	1.49	800	25	1.49
2	100(K)	3.79	75	25(H)	1.86	1000	25	1.56
2.5	150	4.25	75	50	1.49	1000	25(H)	1.86
3	100(K)	3.79	75	75(G)	3.15	1000	50(J)	2.22
4	25	1.56	75	300	6.28	1200	225(P)	6.99
4	50(J)	2.50	80	600(R)	12.28	1200	300	6.28
4	100(K)	3.79	100	25	1.49	1250	50(J)	2.22
4	25(H)	1.86	100	25(H)	1.86	1250	150(L)	5.34
5	50(J)	2.50	100	50	1.49	1500	25	1.56
5	75(G)	3.15	100	100(K)	3.55	1500	25(H)	2.16
7	25	1.49	150	150(L)	5.05	1500	50(J)	2.22
7.5	75(G)	3.15	175	25	1.49	1500	50(J)	2.22
7.5	225(P)	6.99	175	25(H)	1.86	1800	50(J)	2.22
8	25	1.56	175	50(J)	2.49	1800	150(L)	5.62
8	25(H)	1.86	175	25	1.49	2000	25(H)	2.22
8	50(J)	2.50	175	25(H)	1.86	2000	50	2.16
9	50	1.49	185	600(R)	12.28	2250	150(L)	5.62
10	150	4.25	185	25	1.49	2500	25	1.56
10	25(H)	1.86	200	25	1.49	2500	50(J)	2.22
10	50	1.49	200	25(H)	1.86	2500	100(K)	3.71
10	100	3.26	200	100(K)	3.55	2500	150	4.25
12	25(H)	1.86	200	150(L)	5.05	2500	600(R)	12.28
12	50	1.49	225	25	1.56	2500	25	1.56
12	600(R)	12.28	250	25(H)	1.86	3000	100(K)	3.71
12	100(K)	3.55	300	50	1.86	3500	25	1.56
15	25	1.56	300	50(J)	2.22	4000	25	1.56
15	25(H)	1.86	300	75(G)	3.15	5000	25(H)	2.22
15	50	1.86	350	25	1.49	5000	50(J)	2.46
15	50(J)	2.50	350	25(H)	1.86	5000	100(K)	4.04
15	75(G)	3.15	350	150(L)	5.05	7500	50(J)	2.46
15	100	3.25	375	150(L)	5.05	7500	100(K)	4.30
18	150(L)	5.05	400	25	1.49	10000	25	1.98
18	50	1.86	400	75(G)	3.15	10000	50(J)	2.50
20	25(H)	1.86	500	25	1.49	10000	50	1.98
20	50(J)	2.50	500	50	1.86	15000	25	1.98

MEDIUM POWER TRANS. MICAS

MFD	V DC W	Type	Each
.00005	3000	F1	3.15
.00005	5000	F2	4.33
.00009	3000	F1	3.15
.00009	5000	F2	4.33
.0001	3000	F1	3.15
.0001	9000	F3	8.81
.00015	5000	F2	4.33
.0002	5000	F2	4.33
.00022	3000	F1	3.15
.00022	5000	F2	4.33
.00025	5000	F2	4.33
.00025	8000	F3	8.81
.0003	2000	F1	3.15
.0003	3000	F2	4.33
.0004	3000	F1	3.15
.0004	6000	F2	4.33
.0005	8000	F3	8.81
.00062	2000	F1	3.15
.00062	4000	F2	4.33
.0007	6000	F2	4.33
.00072	5000	F2	4.33
.00075	2500	F2	4.33
.0008	1000	F2	4.33
.0008	5000	F2	4.33
.00085	2000	F2	4.33
.0009	5000	F2	4.33
.001	2000	F2	4.33
.0011	5000	F2	4.33
.00125	2000	F1	3.15
.0016	1000	F2	4.33
.0016	2500	F1	3.15
.002	1000	F2	4.33
.002	2000	F2	4.33
.0022	5000	F2	4.33
.0025	2000	F1	3.15
.003	3000	F2	4.33
.004	3000	F2	4.33
.006	3000	F2	4.33
.006	6000	F2	12.34
.0075	1500	F1	3.15
.0075	1500	F2	4.33
.008	3000	F2	4.33
.01	8000	F3	13.60
.02	1000	F2	4.33
.024	1500	F2	4.33
.025	1200	F2	4.33
.025	1500	F2	4.33
.033	1500	F2	4.33
.047	1500	F2	4.33

HIGH POWER TRANSMITTING MICAS

G-1 (CM 75)

.0001	6 KV	12.18	.001	6 KV	14.00
.00015	5 KV	12.18	.0015	6 KV	14.96
.00015	10 KV	14.54	.002	5 KV	15.44
.0002	6 KV	12.18	.002	7 KV	16.44
.00024	6 KV	12.18	.002	8 KV	17.44
.00025	6 KV	12.76	.005	1.5 KV	16.31
.0004	6 KV	13.31	.08	1.5 KV	19.73
.0006	6 KV	13.80	.09	1.5 KV	20.25
.00062	6 KV	14.00			

G-2 (CM 80)

.0001	10 KV	15.67	.0005	10 KV	19.67
.00015	10 KV	15.67	.001	10 KV	19.67
.00027	10 KV	15.67	.002	10 KV	19.67
.0003	10 KV	15.67	.004	9 KV	19.67
.00033	10 KV	15.67	.005	5 KV	20.76
.00039	10 KV	15.67	.01	3 KV	21.00
.0004	5 KV	15.67	.015	2 KV	21.00
			.046	2 KV	21.00

G-3 (CM 85)

.00005	20 KV	33.27	.0011	20 KV	43.60
.0001	20 KV	36.36	.0012	20 KV	44.52
.00015	15 KV	37.80	.00124	20 KV	44.76
.00018	20 KV	37.80	.002	12 KV	42.35
.0002	20 KV	38.75	.0025	12 KV	45.00
.00025	20 KV	39.33	.006	10 KV	45.35
.0003	20 KV	39.33	.015	5 KV	42.35
.0004	20 KV	41.35	.015	7 KV	45.50
.00047	20 KV	41.35	.02	5 KV	45.50
.0005	20 KV	41.35	.05	4 KV	45.81
.00055	5 KV	42.35	.15	2.5 KV	45.81
.001	15 KV	41.35	.25	1.6 KV	49.81
	20 KV	44.50			

G-4 (CM 90)

.00025	30 KV	66.35	.0005	15 KV	75.68
.0003	25 KV	66.35	.0025	15 KV	78.00
.00032	25 KV	66.35	.0001	12 KV	70.60
.00033	30 KV	67.25	.01162	5 KV	54.95
.00065	30 KV	67.50	.012	10 KV	54.95
.001	25 KV	68.73	.022	6 KV	54.95
.001	30 KV	75.50	.02325	3 KV	54.95
.0015	25 KV	68.73	.02448	3 KV	54.95
.0016	25 KV	68.73	.03076	2.5 KV	54.95
.002	30 KV	71.50	.03156	2.5 KV	54.95
.0025	25 KV	72.50	.04228	2 KV	54.95
.003	30 KV	72.50	.04100	2 KV	54.95
.0019	30 KV	72.50	.05	5 KV	82.50
.0044	20 KV	72.50	.052	5 KV	54.95
.00444	15 KV	73.62	.05668	2 KV	54.95
.006	15 KV	75.62	.06805	1.5 KV	54.95

G-5 (CM 95)

.000155	30 KV	135.20	.000332	30 KV	151.80
.0004	30 KV	135.20	.001	30 KV	165.30

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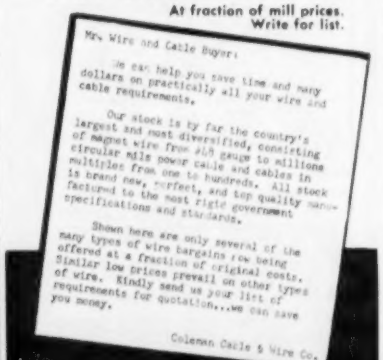
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TS-4A/AP	ARC-1
TS-19A and B	ARC-3
TS-12/AP	ARC-4
TS-13/AP	ARC-5
TS-14	AR-88
TS-16/AP	ART-13
TS-35A/AP	CR-91
TS-36/AP	SLR
TS-61/AP	RAK
TS-62/AP	RAL
TS-74/UPM	RAO
TS-89/AP	RBB
TS-98	RBO
TS-101/AP	RBG
TS-104	RBL
TS-110	RBA
TS-125/AP	RBM
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TDQ	1000
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220/1/60 to 110/1/400 @ 2kva	435.00
440/3/60 to 110/1/400 @ 2kva	435.00
32dc to 110/1/60 @ 350va	100.00
110dc to 110/1/60 @ 350va	100.00
110dc to 28dc @ 250va	95.00
110/1/60 to 28dc @ 250va	115.00
220/1, 3/60 to 28dc @ 250va	115.00
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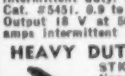

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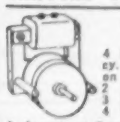

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4 RPM on 50 cy. or 4¼ RPM on 60 cy.	$2.95	3.6 RPM	3.15
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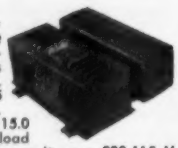

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.02	8	4.50	.25	15	9.95
.02	20	6.75	.25	20	15.95
.025	50	17.95	.25	50	44.50
.025/.025	50	34.50	1.	7.5	6.95
.3	3	1.75	1.	15	29.50
.1	4.5	3.50	2.	5.5	9.50

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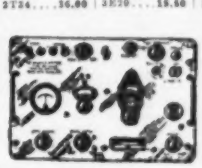
Standard brands. First grade only. No pull outs. No rejects. No rebrands. At lowest prices. Wholesale and export only.

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
OA2	$1.00	2J36	90.00	3GP1	5.00	LM18	200.00	388A	3.00	802	3.95	1500T	135.00
OA3	3.10	2J38	5.95	5J21	75.00	1AE	1.75	393A	7.50	803	5.95	HK1354	75.00
OB2	.95	2J39	8.95	4B26	5.40	1AB	.75	394A	3.95	805	6.95	1004	5.00
OB3	1.10	2J40	29.00	4C27	10.00	ME16	.90	MX408C	.50	807	1.25	1012	1.50
OC3	.96	2J42	135.00	4C28	35.00	20A	.75	417A	15.00	808	1.95	1613	1.25
OD3	.85	2J49	60.00	4E27	16.00	KY21A	8.25	434A	15.00	809	2.95	1616	1.25
CIB	2.95	2J50	15.00	4J25	90.00	RK21	2.00	446A	1.95	810	10.00	1621	.45
1B22	1.50	2J55	150.00	4J26	50.00	RX21	8.00	446B	3.95	811A	3.75	1622	1.50
1B23	5.95	2J56	310.00	4J27	50.00	KU24G	1.50	450TL	85.00	812A	3.95	1624	1.75
1B24	12.00	2J61	20.00	4J28	50.00	25Z	.75	450TH	52.50	813	13.75	1625	.35
1B26	1.75	2J61A	25.00	4J29	50.00	RK39	2.75	464A	7.50	814	1.75	1626	.25
1B27	12.50	2J62	15.00	4J30	50.00	HF50	1.75	471A	1.25	815	3.25	1851	1.00
1B32	1.10	2K22	15.00	4J31	150.00	HK54	1.00	527	10.00	816	1.25	2000T	150.00
1B50	23.00	2K32	15.00	4J32	150.00	RK72	1.00	WL530	25.00	829	11.00	2050	1.00
1B51	7.50	2K35	19.50	4J33	150.00	RK73	1.00	WL531	22.50	829A	12.00	2051	1.00
1B56	35.00	2K36	60.00	4J34	150.00	PC95	19.95	WL532	16.00	829B	16.00		
1B60	35.00	2K38	35.00	4J35	150.00	100TH	7.95	HK654	35.00	830B	2.00		
1N21	.85	2K39	35.00	4J36	150.00	FG105	20.00	700A/D	10.00	832A	5.95	Various 5000 and 6000 series of new production	
1N21A	.95	2K39A	35.00	4J37	150.00	122A	1.75	701A	4.50	833A	45.00		
1N21B	1.50	2K39	140.00	4J38	150.00	203A	7.50	703A	3.95	834	7.50		
1N21C	12.50	2K41	135.00	4J39	150.00	211	.95	704A	1.95	836	3.95		
1N22	.90	2K42	180.00	4J40	150.00	211C	12.00	705A	2.75	837	3.95		
1N23	.90	2K43	199.00	4J41	150.00	242C	10.50	706AY/		838	5.95		
1N23A	.90	2K44	195.00	4J42	150.00	244C	9.50	FY	25.00	849	16.00		
1N23B	1.25	2K45	60.00	4J43	150.00	249C	4.50	707A	5.75	857B	125.00	5820	475.00
1N23C	7.50	2K48	95.00	4J52	225.00	250TH	19.95	707B	15.00	860	3.50	5826	450.00
1N25	4.50	4K50	295.00	4J53	225.00	250TL	19.95	716AY	16.00	861	25.00	6012	2.00
1N26	3.75	5AP1	5.00	5BP1	5.00	252A	5.00	715A	4.50	866A	1.25	6012A	2.00
1N27	3.50	5BP1	25.00	5BP2A	12.00	274B	5.00	715B	9.00	866B	67.50	6013	3.00
1N34A	.79	5BP6	72.00	5BP4	3.95	304TH	10.00	715C	22.50	866B	X 60.00	6013A	3.50
1N35	2.75	5BP8A	180.00	5CP1	7.50	304TL	10.00	717A	4.50	872A	1.95	6072A	3.50
1P25	75.00	5BP1	7.20	5CP7	9.95	307A	3.50	719A	22.50	874	2.25	6020	1.00
2C39A	12.50	5BP4	5.50	5CP7A	18.00	310A	4.50	720AY/		878	1.50	6021	1.00
2C40	15.00	5BP8	5.50	5CP12	35.00	310B	4.50	GY	30.00	879	1.50	P14B16S	96.00
2C43	14.50	5BP9	5.00	5D21	10.00	311A	6.50	721A	5.50	884	1.50	9001	1.62
2C44	.60	5BP9	8.00	5JP1	27.50	312A	3.50	721B	7.50	885	1.50	9002	.90
2C46	7.50	5LG3	5.50	5JP2	15.50	323A	15.00	723A/B	18.00	902P1	.75	9003	1.20
2IA	12.00	5C22	75.00	5JP4	27.50	327A	3.75	724A	1.95	931A	5.00	9004	.35
2J22	9.00	5C24	1.75	5J23	26.00	328A	6.75	726B	2.25	954	.35	9005	2.20
2J25	15.00	5C31	2.95	5LP1A	25.00	350A	4.50	726C	15.00	955	.50	9006	.70
2J27	15.00	5DP1	7.50	C6A	11.00	350B	5.95	726A	18.00	956	.75		
2J31	24.00	5DP1A	10.00	C6J	7.50	HK354C	15.00	726B	45.00	957	.25	Thousands of other tubes	
2J32	29.00	5DP1A		7BP7	5.00	357A	15.00	726C	45.00	958A	.50		
2J33	32.00	5EP1	5.00	12AP4	30.00	368AS	4.95	730A	22.50	959	2.25		
2T24	16.00	5EP9	15.00	12DF7A	10.00	371B	1.50	750TL	45.00	E1148	.25		
						385A	4.50	801A	.90	1280	.25		



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Test Set TS 147 UP is a portable Microwave Signal Generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency range of 8500 MC to 9600 MC.

NEW UNUSED SURPLUS TS 259 K BAND

23400-24500 MEGACYCLES SIGNAL GENERATOR

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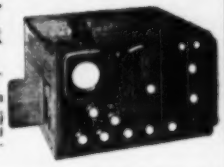

Field type X Band Spectrum Analyzer. Band 8430-9580 Megacycles.

Will Check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available now complete with all accessories, in carrying case.

SPECIAL! 5,000 V. POWER SUPPLY

For IP25 Infrared Image Converter from 3 V. Battery Source. NEW, Complete with RCA 1654 Tube..... **$990**

OTHER TEST EQUIPMENT USED CHECKED OUT, SURPLUS

TSKI/SE	T35/AP	TS108	TS226	*Surplus Equip.*
TS3A/AP	TS36/AP	TS110/AP	TS239A-TS239C	APA10
RF4/AP	1-96A	TS125/AP	TS251	APA38
TS12/AP	TS-45	TS126/AP	TS258	APS 3 APS 4
TS13/AP	TS47/APR	TS147	TS270	APR4
TS14/AP	TS69/AP	TS174/AP	TF890/1	APR5A
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0A3	.98	4J67	485.00	703A	1.48	5670	2.24	5963	37.25
0B2	.98	4J67	485.00	704A	1.98	5675	2.24	6021	1.75
0B3/VR90	.66	4X150A	16.00	705A	.98	5676	1.55	6027	179.95
0C3/VR105	.82	5C22	29.50	715A	1.48	5686	2.99	6072	3.99
0D3/VR150	.78	5D21	9.95	715B	12.90	5687	2.99	6080	3.95
1AD4	3.95	5U4G	.45	717A	.35	5692	6.48	6090	1.55
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1AX2	1.25	6AS6	1.25	721AB	9.98	CK5654	1.70	6110	1.55
1B3	.66	6AS7G	2.98	724A	2.94	CK5697	1.79	CK6333	8.95
1B24	4.98	6J6	.48	724B	.96	CK5702	2.50	6215	6.48
1B46	1.88	6SN7	.56	725A	4.45	5704	2.25	6121	9.00
1B46A	42.50	6V6GT	.56	807	1.15	5713	173.50	GL6136	1.89
1D21	.49	6X4	.47	807W	1.25	5718	5.99	6146	4.87
1Q23	166.00	7C25	125.00	814	2.48	5719	5.99	6164	64.95
1R2A	.67	8D21	99.00	815	1.98	5721	189.88	6199	49.99
2C39A	16.90	12AU7	.54	829B	8.45	5722	6.39	6336	2.98
2C51	2.98	12AX7	.58	832A	5.49	GL5727	1.77	6378	199.95
2C53	.75	25T/GT	2.00	866	.34	5732	2.94	6271	159.95
2E22	1.89	35W4	.38	927	1.36	5735	6.99	6906	1.15
2E24	2.48	24G	1.96	954	.18	5744	2.35	8005	4.97
2K25	1.78	HN24	4.98	955	.65	5749	1.72	8012	1.89
2K32	2.07	102S	.46	956	.32	5750	3.10	8013	4.91
2K41	1.45	722A	4.49	957	.32	5763	3.10	8014A	60.15
2J30	50.50	66L6	.68	CK1005	.56	5764	55.99	8020	2.98
2J42	99.50	71A	.74	1612	1.98	5765	55.99	8025A	2.99
2K28	72.50	HY65	5.49	1631	1.27	5767	290.00	9001	.48
2K29	29.50	GK105	699.99	1616	.79	CK5781	5.95	9002	.56
2K30	Q	GK202	99.99	1619	.34	CK5787	4.95	9003	.98
2K34	130.00	701A	7.38	1620	9.01	5794	8.99	9006	.15
2K35	219.48	21S	10.35	1625	.44	5812	2.99	C-Ray Tubes	
2K36	Q	213A	2.92	1626	.16	5813	2.99		
2K41	175.00	250R	10.95	1629	.22	5819	49.99	1BP1A	6.88
2K42	149.51	HK254	18.00	1632	.68	5820	65.00	1CP1GL	6.98
2K43	149.50	HY2504	18.00	1633	.68	5821	1.25	1DP1	4.81
2K44	Q	384TH	15.00	1642	.62	5825	11.99	1DP1A	6.88
2K48	110.00	384TL	15.00	1644	.99	5828	6.70	1EP1	4.75
2K49	72.50	811	.49	1654A	99.00	5829	4.98	1FP1	5.91
2P21	298.00	388A	1.99	2050	.98	5841	7.98	1FP7A	6.91
3B24W	8.48	394A	1.96	2050W	2.48	5842	11.00	1GP1	1.91
3C22	72.50	434A	3.94	2051	.68	5844	1.00	1HP1	1.98
3C24	7.98	446B	2.98	5516	4.69	5852	7.57	1LP1A	14.48
3D21A	7.99	450TH	70.45	5518	5.51	5867	59.50	1LP1	5.88
3J31	225.00	502AX	2.05	5517	2.22	5963	49.94	1MP1	1.91
3X2500A		512AX	1.35	5586	166.25	CK5875	2.05	1JP1	14.95
	325.00	531DX	1.49	5588	135.50	5876	12.49	1KP1	11.94
4-65A	19.49	536AX	1.55	5634	7.50	5879	1.69	1LP1	9.91
4-125A	39.95	538AX	1.55	5640	11.57	5881	2.70	1SP1	100.00
4B27	16.98	539DX	2.50	5641	6.59	5883	7.55	7BP7	6.50
4B27	4.98	544DX	2.50	5642	.99	5910	.74		
4C35	16.95	571A	4.45	5654	1.72	5927	89.45		
4J26	79.55	608CX	.97	5656	9.98	5932	5.00		

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25mmf/7.5Kv @ $4.50, 3 for $10
50mmf/7.5Kv @ $6.50, 4 for $20
100mmf/20Kv @ $7, 4 for $25
140mmf/20Kv @ $9, 3 for $25
50mmf/20Kv @ $10, 3 for $25
100mmf/20Kv @ $12, 3 for $30
12mmf/32Kv @ $16, 3 for $36
Buy $100 & Deduct 20% Discount

MICRO-POSITIONER, Barber-Colman AYLZ3822-S polarized DC relay Dble coil, differential current sens. 50v max for remote control positioning $5.50; 2/$10

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Heinemann Magn. Bkrs. Amps: 3, 5, 7, 9, 10, 12, 15, 20, 30, 40, 50, 60 @ $5.98 ea; 12/$69; 10/$76
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Push to Reset
Amps 3-5-7-10-15-20 Ea 27¢; 4 for $1; 25 for $5; 100 for $18
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Fuse is 25/0 size. Proper state Amps (Current) desired. **Kit of 50 $1.50**

DELAY LINE, Millen 1 Micro sec'd @ $7.95; ..... 4/$30.00
DELAY LINE, ESC #2200/0.4 Micro sec'd ..... @$2; 6/$10

$ $ PRICE SLASHED $ $

***30¢** "J" POTS

* As Priced Below

Ohms	Shaft	B	Ohms	Shaft	B
5	1/16	1/4	10K	1/8S	1/2L
65	1/8	1/4	100K	1/8S	1/2L
250	1/2	1/4	50K	1/2	1/2
500	1/8S	1/4	70K	1/4	1/4
500	1/2	1/4	100K	1/2	1/2
1500	1/4	13/16	*1500/50	1/4	1/4
2K	1/2	1/4	*1500/500	9/16	1/4
2K	1/4S	1/4	*25K	1/4	1/4
2K	13/16	1/4	*25K/450	1/2	1/2
2500	9/16S	1/4	*25K/5K	1/2	1/2
3K	1/2	1/4	*50K/1K	1/4	1/4
3K	13/16	1/4	*50K/5K	1/4	1/4
5K	1/8S	1/2L	*10meg	1/8S	1/8
10K	1/8S	1/4	*250K	1/4	1/8
10K	1/4	1/4	*750K	11/8	1/8
25K	1/8S	1/2L	*750K	13/4	1/8
25K	1/4	1/4	*1meg	13/4	1/8

Shaft @ .50 ea; 12 or more asst'd @ .40 ea; 100 Lot Dual @ .*.10 ea
* To 1 5/16" @ .65 ea; 12 or more asst'd @ .55 ea; Special 100 Lot @ .50 ea
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Asst'd Kit, Pots ..... 12 for $4.00
@ Bushing & Screwdriver Shaft L Locking

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"TAB" No.	Replaces	W-Sec Max	Each
TWL	PA 104/PF11B	150	$5.98
THU	Amglo 8814X	100	10.98
230T	PF 200	200	5.98
THVA	SYLV. 4330	200	5.98
VAYA	5400	200	10.98
TLX	5500 & PA106	200	10.98
TDZ	DXC/250-850	150	16.00
5BUTG	PF 605	2000	49.95
TRIGGER COIL LO VOLT FLASH			5.98
$25MFD/450VDC/52	W'sonde COND new low esr, best		5.98
esr, best famous mfgr			5/$25

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ALL BRAND NEW • ORIGINAL FACTORY SEALED CARTONS
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Write for Free CBS Receiving Tube Chart
50%+10% OFF ON LOTS OF 25 TUBES OR MORE

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75 MEG "MVP" 10W/10KV	69¢ 12 for $6.00
2MEG 5W/10KV	89¢ 12 for $9.00
5 MEG "MVP" 5W/7.5KV	89¢ 12 for $8.00
7 MEG "MVP" 10W/10KV	$1.00 12 for $10.00
12 MEG 10W/10KV	$1.50 12 for $16.00
20 MEG "MVP" 25W/20KV	$2.00 12 for $20.00
30 MEG "MVP" 25W/40KV	$2.50 12 for $25.00
10 MEG "MVP" 10W/10KV	$2.00 12 for $20.00

Lots Fifty 20% Disc; Lots 100 Disc. 40%

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Image-Converter Tube Hi-Sensitivity simplified design 2" dia. With built-in screen—Resolution up to 350 lin/in. Tube & Data **"TAB" 59 @ 2 for $16, 12 for $84**

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FENWAL THERMOSWITCH, #17300-24 Precision Adjustable Knob Temp Control—100 to +400°F/10A/115VAC ..... **$4.95; 2/$8**

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"Grain of Wheat"

323 Volts 2 CLEAR ..... 5 for $1
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Discount 100 Qtys 15%; Qtys 1000 @ 30%

NEW PRECISION POTENTIOMETERS

Helipot 1000 Ohm/0.5%/10 Turn
Helipot 2000 Ohm/0.5%/10 Turn
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Microspot 5000 Ohm/0.1%/10 Turn
Micropot 2000 Ohm/0.1%/10
SPECIAL ..... $6.49 ea; 6 for $24
$100 or more 20% Discount

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6KV DC & AC
27 Range
MULTITESTER
(Not a Kit)

"TAB" 60 $21.95 ea
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A complete precision test instrument ► **20,000 Ohms per Volt DC, 10,000 Ohms p/v AC.** ◄ 5" 38 microamperes movement. 6" S cale to read scales—DC 0-6, 30, 150, 600, 3000, 12000, 60000 Volts. AC 0-6, 30, 120, 600, 1200 Volts. Current 0-60 ua, 6, 60, 600 ma. Resistance 0-8K, 80K, 800K, 8 megohms. Decibels Cal 600 ohm —20 to +6, 20, 34, 46, 60 DBs. Capacity 250 uufd to 10mfd. Inductance 10 to 1000 mi/hys. Hi accuracy, versatile, 1% Precision Resistors, Scale 2". Plastic engraved panel. Rugged metal case. Lgth 4¼" x 6¾" x 2¾". Complete w/batteries & leads. RF Diode Probe included for signal measurement. Shpg. wt. 4 lbs.
"TAB" SPECIAL ..... @ $22.95 ea
HV PROBE, 30,000 Volts ..... **$5.95 ea**

POCKET AC-DC Multitester

"TAB" 27C $9.45 ea
Lots of 3

Hi-accuracy precision TOM. 1000 Ohms per V. Reads AC & DC Volts 0, 5, 25, 250, 1000V DCMA: 0, 1, 10, 100 MA. Ohms 0, 10, 100K. Size 3½ x 4¾ x 1¾". Test Leads. **Sold Singly $9.95; (plus 40¢ shp in U. S. A.)**
Dealers Distributor Write for Discounts

EDISON TIME DELAY RELAYS, Octal base, 28 or 120 V @$1.49; asstd 10@$12

RHEOSTAT SALE

6 Ohm 25W	.88; 12/$7
15 Ohm 25W	.98; 12/$7
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500 Ohm 25W	1.10; 10/$7
1500 Ohm 25W	1.10; 10/$7
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10	6.50	12.50	19.50	24.00	41.75	84.85	4.75	36.90	71.95
12	8.00	15.75	22.10	29.75	44.25	99.85	5.95	41.90	81.95
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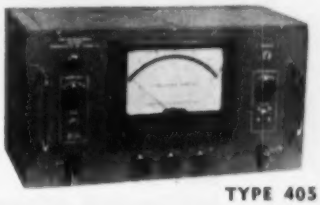

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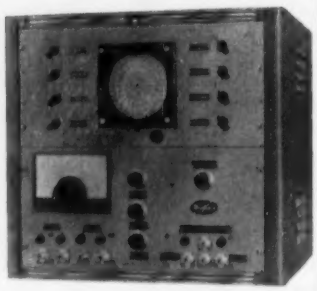

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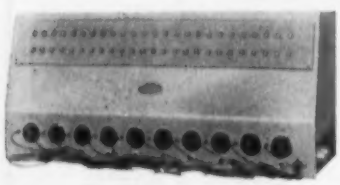

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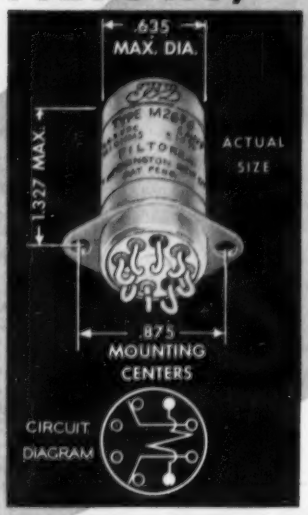

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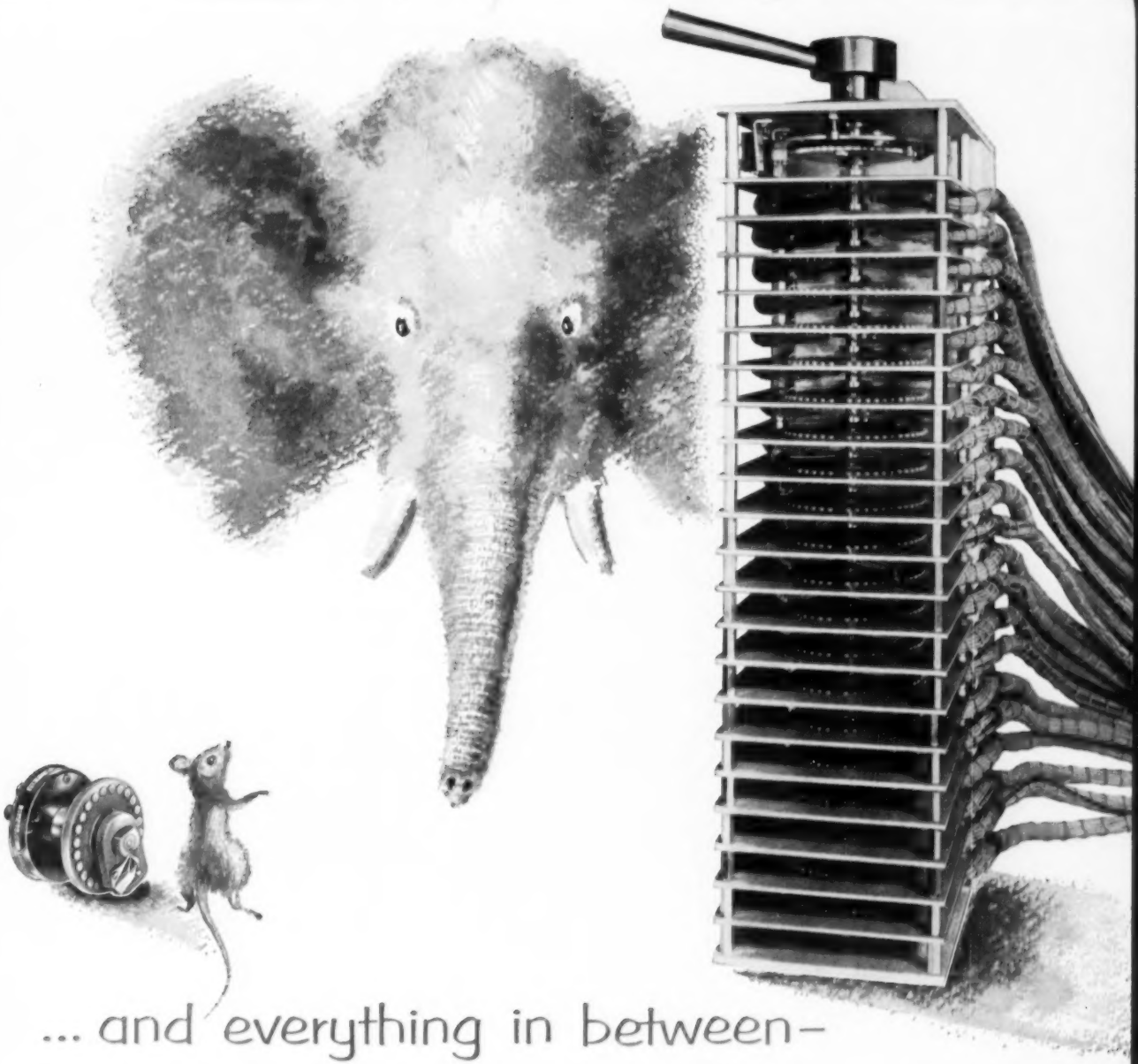

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